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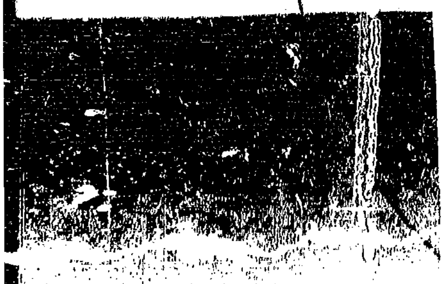
GEOPHYSICAL RESEARCH PAPERS
No. 59

PROJECT PRAIRIE GRASS, A FIELD PROGRAM IN DIFFUSION
VOLUME II

EDITED BY
MORTON L. BARAD

JULY 1958



GRD

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GEOPHYSICAL RESEARCH PAPERS

No. 59

PROJECT PRAIRIE GRASS, A FIELD PROGRAM IN DIFFUSION

Volume II

Edited by
MORTON L. BARAD

July 1958

Project 7657

Atmospheric Analysis Laboratory
GEOPHYSICS RESEARCH DIRECTORATE
AIR FORCE CAMBRIDGE RESEARCH CENTER
AIR RESEARCH AND DEVELOPMENT COMMAND
UNITED STATES AIR FORCE
Bedford, Mass.

ABSTRACT

Project Prairie Grass was a field program designed to provide experimental data on the diffusion of a tracer gas over a range of 800 m. In each of 70 experiments the gas was released continuously for 10 min at a source located near ground level. The gas releases were made over a flat prairie in Nebraska under a variety of meteorological conditions during July and August of 1956.

~~This paper, published in two volumes, includes~~ a brief history of the project is included with ~~and~~ detailed descriptions of the tracer technique and the meteorological equipment employed in the field program. Tabulations of the diffusion data and the meteorological data collected during the gas releases are also presented. In addition, ~~this paper contains~~ data are contained on the heat budget at the air-earth interface during other selected periods during the summer of 1956.

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CHAPTER 7
INSTRUMENTATION USED BY THE TEXAS A&M GROUP

R.L. Richman* and W. Covey
Texas A&M Research Foundation

7.1 The Mobile Micrometeorological Station

The mobile micrometeorological station of the Texas A&M group was installed at the extreme west end of the observation line (Figure. 7.1). Figure 7.2 shows the relative locations of the component elements of the station. The station consisted of (a) a slender aluminum pipe mast supporting six anemometers at heights of 8, 4, 2, 1, 0.5, and 0.25 meters, (b) a similar mast supporting seven temperature measuring, radiation shielded, copper-constantan thermocouple junctions at heights of 8, 4, 2, 1, 0.5, 0.25, and 0.125 meters, (c) a similar mast supporting seven polyethylene air sampling tubes at heights of 8, 4, 1, 0.5, 0.25, and 0.125 meters, (d) a triangular section, tubular steel, fold-over type tower supporting at a height of 16 meters an air sampling tube, an anemometer, a shielded thermocouple, a wind vane and a radioactive point collector, (e) a U. S. Signal Corps instrument shelter housing maximum and minimum thermometers and a thermograph, (f) an 8-inch rain gauge and a weighing type recording rain gauge, (g) a wind vane supported at a height of 1 meter by an iron pipe stake, (h) a Gier and Dunkle net exchange radiometer supported at a height of 1 meter, (i) an inverted Eppley thermoelectrical pyrheliometer supported by an iron pipe standard at a height of 2 meters to receive reflected short-wave radiation, (j) an instrument trailer which housed indicating and recording apparatus, (k) an Eppley pyrheliometer mounted on the roof of the trailer, (l) two differentially connected shielded thermocouple measuring junctions supported by a pipe stake at heights of 1/2 and 1 meter, and (m) six copper-constantan temperature measuring junctions at depths of 3.125, 6.25, 12.5, 25, 50, and 100 cm in the

*Present affiliation: U. S. Navy Electronics Laboratory

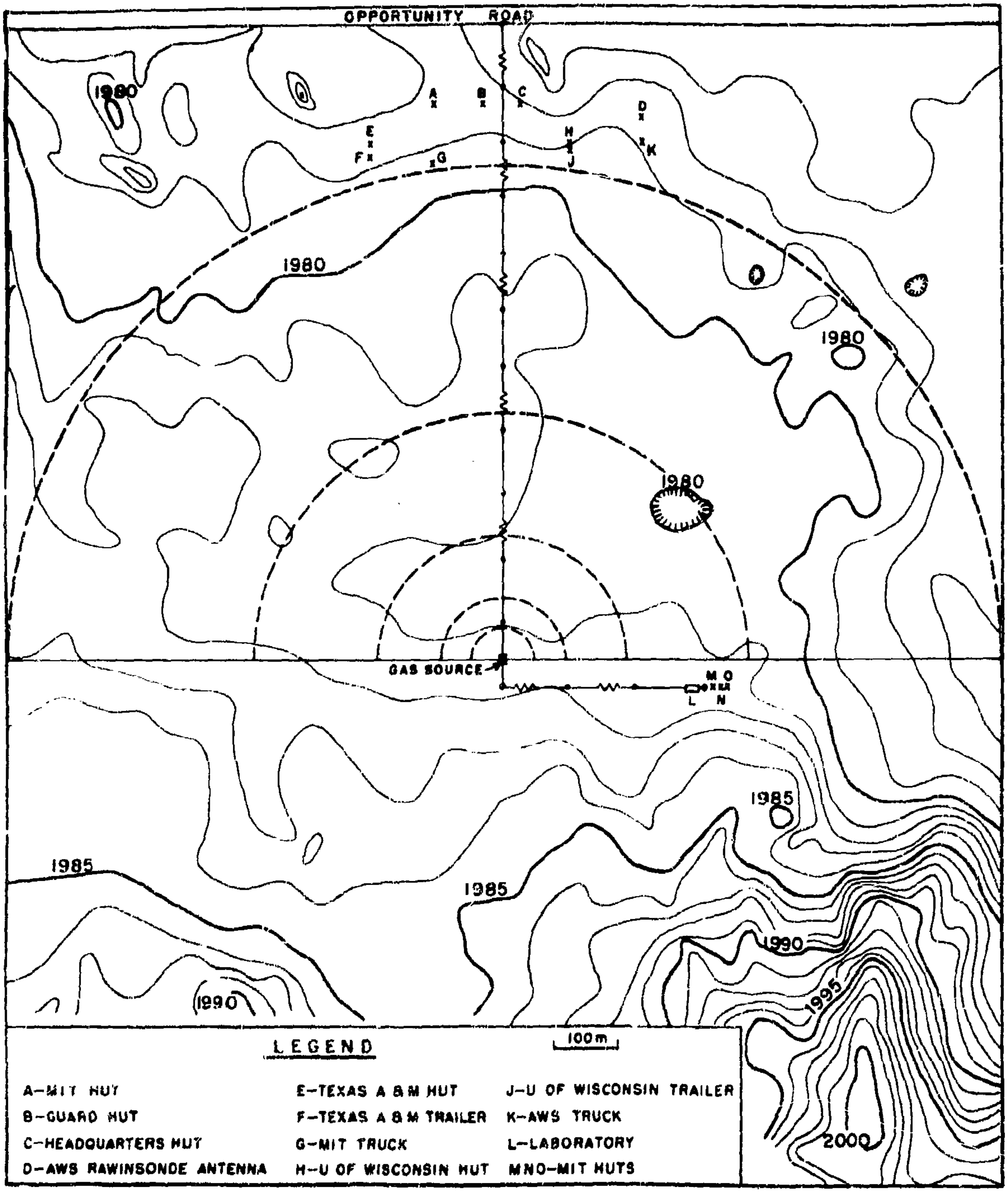


Figure 7.1 Topography of field site and layout of equipment

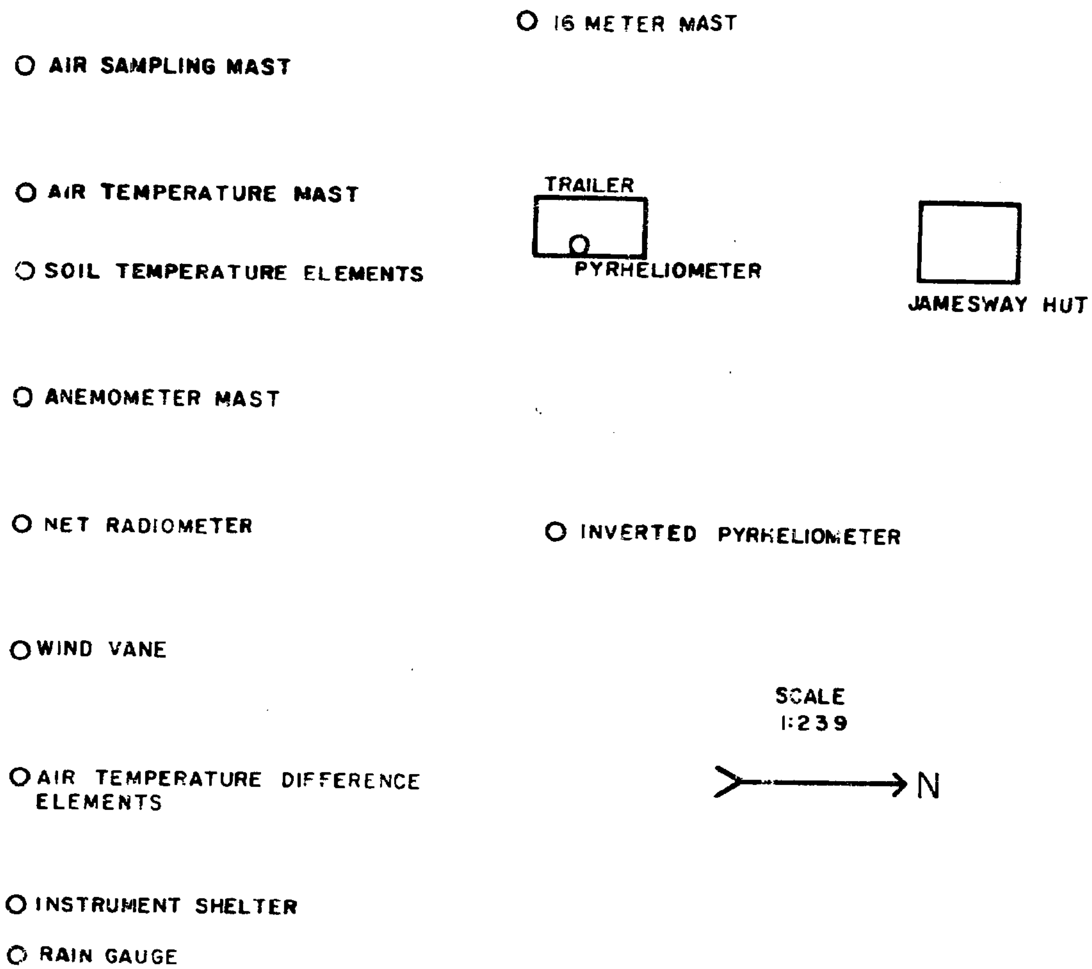


Figure 7.2 The micrometeorological station (Texas A and M)

soil. Figure 7.3 illustrates the vertical distribution of the sensing elements.

The instrument trailer was a 15-foot house trailer shell, the interior of which was designed to accommodate the recording and indicating equipment associated with the exposed sensing elements.[5] Figures 7.4 and 7.5 illustrate the assignment of space in the trailer. The principal instruments were (a) a Thornthwaite dew-point hygrometer and associated air sampling apparatus, (b) a group of six recording milliammeters with modulated-carrier-type d-c amplifiers for recording insolation, reflected short-wave radiation, net radiation, temperature differences, wind direction, and absolute temperatures, (c) a temperature indicating system with a switch for selecting thermocouple measuring junctions, and (d) a counting system for indicating the number of turns of the anemometers, that is, for recording wind profiles. These instruments will be discussed individually and described in detail. In addition, space was provided for computing and plotting data, storing spare parts, and storing the sensing elements and supporting structures during transit.

7.2 Observation Procedure

Most of the observations were made during periods which centered about five minutes after the hour Central Standard Time. The procedure during such observations is listed below. A similar procedure was followed for periods centered about other times.

1. Ten minutes before the hour: measurement of soil temperature at 6 depths.

2. Five minutes before the hour: start of the anemometer counting period; start of the air sampling period; start of the recording period for insolation, net radiation, reflected short-wave radiation, temperature difference, and wind direction; start of the air temperature measurements. (Eight measurements of air temperature, one at each height, were made each minute for a 20-minute period.)

3. Fifteen minutes after the hour: ending of observation period which was started at five minutes before the hour.

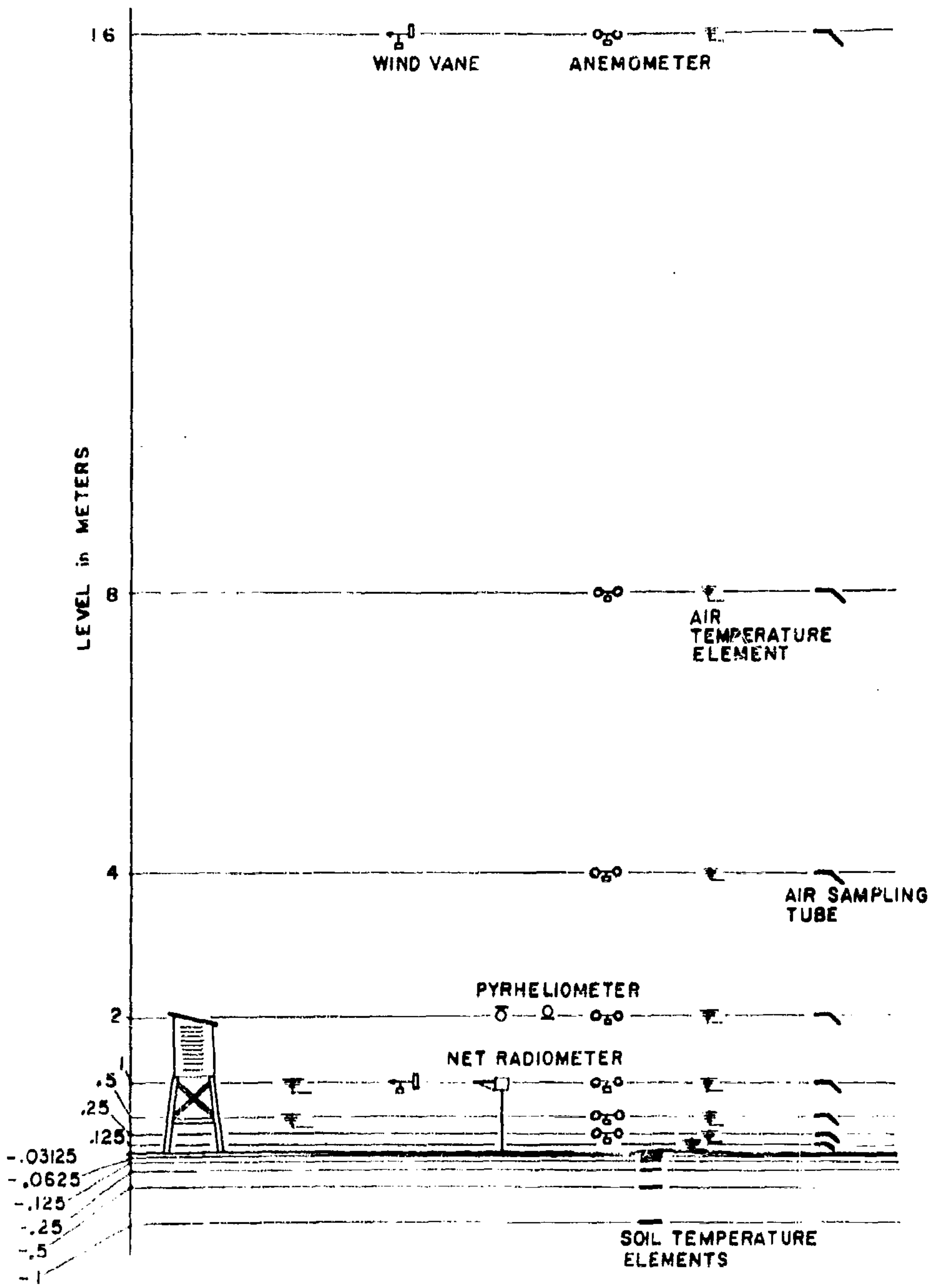
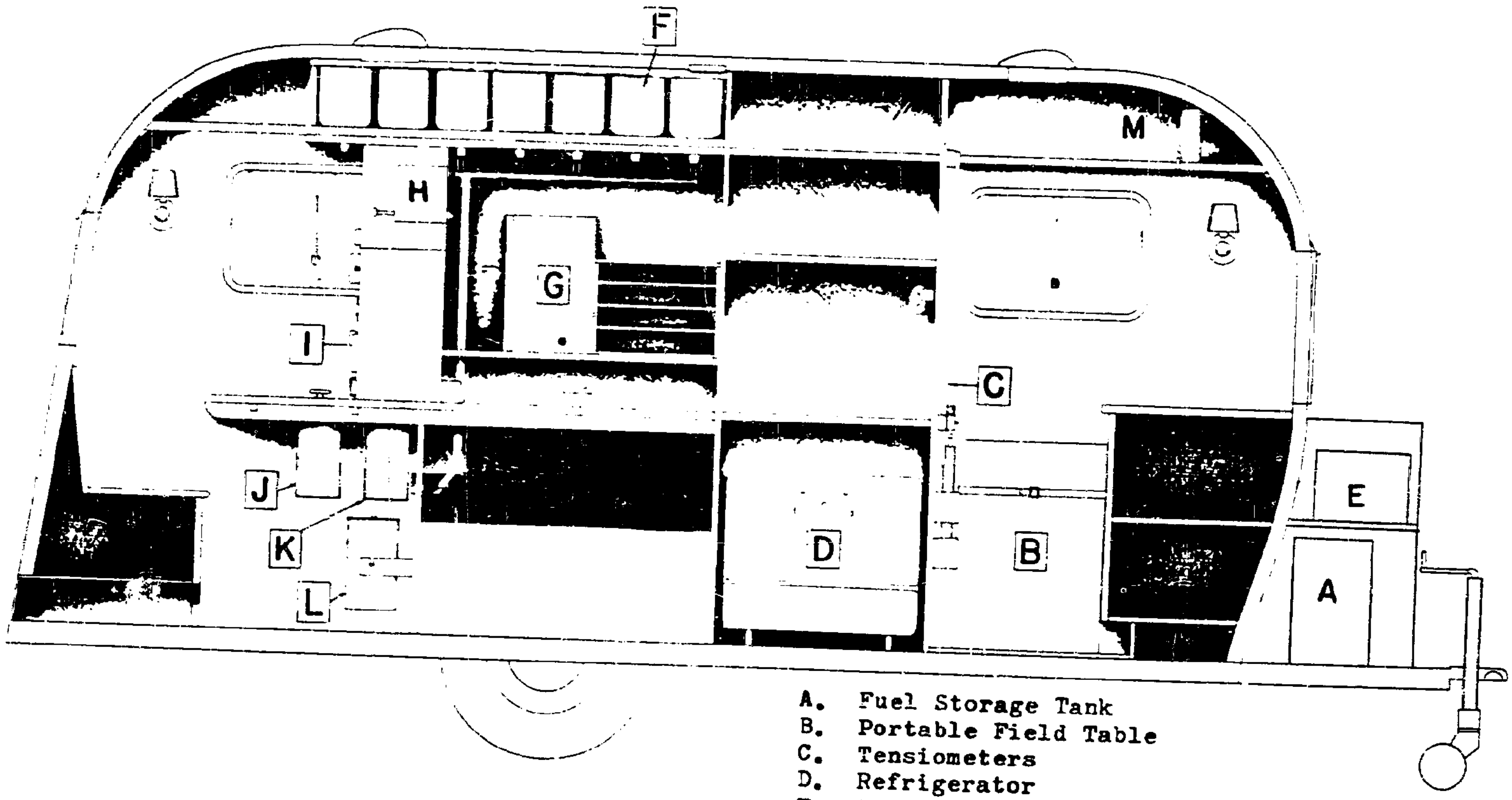
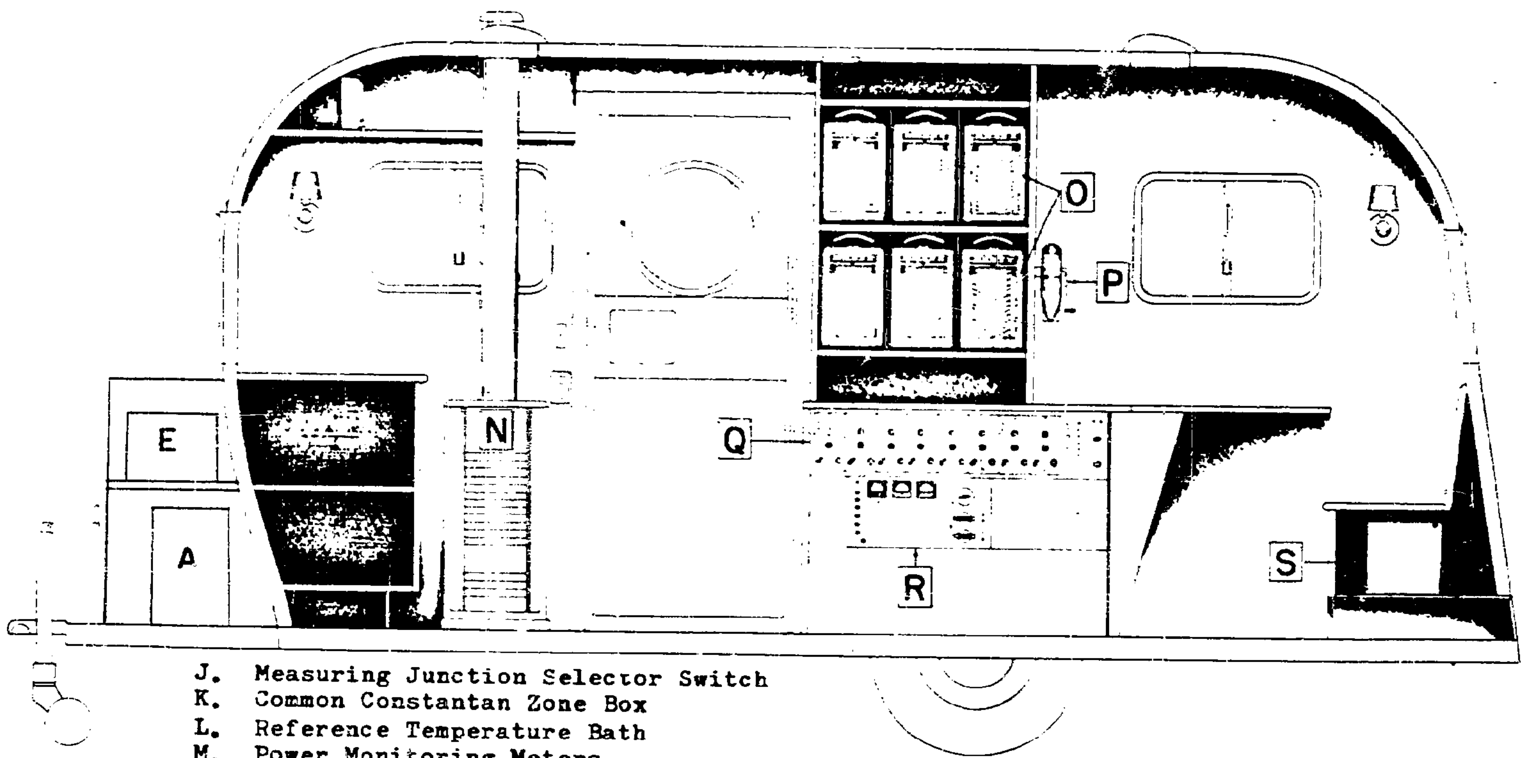


Figure 7.3 Vertical distribution of the sensing elements



A. Fuel Storage Tank
B. Portable Field Table
C. Tensiometers
D. Refrigerator
E. A-C Power Regulator
F. Air Sample Storage Jugs
G. Dew-Point Hygrometer
H. Dew-Point Control Unit
I. Main Instrument Panel

Figure 7.4 Instrument trailer interior



J. Measuring Junction Selector Switch
K. Common Constantan Zone Box
L. Reference Temperature Bath
M. Power Monitoring Meters
N. Kerosene Stove
O. Esterline-Angus Recorders
P. Ice Crusher
Q. Bank of Amplifiers for Recorders
R. 10 Unit Power Supply for Amplifiers
S. Wind Speed Counting Unit

Figure 7.5 Instrument trailer interior

4. Seventeen minutes after the hour: second measurement of soil temperatures.

5. Twenty minutes after the hour: measurement of the dew-points of the 8 air samples obtained during the air sampling period. (One sample was obtained for each height.)

All data reported are average values for the observation period.

7.3 Individual Elements

7.3.1 Insolation Incoming short-wave radiation was measured by an Eppley pyrheliometer (Weather Bureau 10-junction type). The output of the pyrheliometer was continuously recorded by a modulated-carrier-type d-c amplifier (Figure 7.11) and an Esterline-Angus graphic ammeter. The amplifier was equipped with a gain selector switch so that the recording sensitivity could be changed. Three recording scales were thus provided, 0 to 0.025 cal cm^{-2} sec^{-1}, 0 to 0.01 cal cm^{-2} sec^{-1}, and 0 to 0.0025 cal cm^{-2} sec^{-1}.

The calibration factor for the pyrheliometer was determined by the manufacturer and assumed to be correct. The amplifier and recorder combined were calibrated by supplying an input voltage from a calibrated voltage source. The voltage source had been calibrated by a Leeds and Northrup potentiometer (Type K).

The calibrated voltage source (Figure 7.6) is extremely stable and was used in the field for periodic checks of the calibrations of the various amplifier-recorder systems.

7.3.2 Reflected Short-Wave Radiation Short-wave radiation reflected by the surface was measured and recorded by a system which was identical to that used for insolation measurements. In measuring reflected radiation, the Eppley pyrheliometer was mounted at a height of 2 meters and inverted so that this radiation was incident on the sensitive element.

The calibration of this system was determined in the same manner as that of the insolation system.

7.3.3 Net Radiation A Beckman and Whitley thermal radiometer, Model N188-1 (Gier and Dunkle net exchange radiometer), was used in measuring the net radiation.[3] A continuous record of the net radiometer

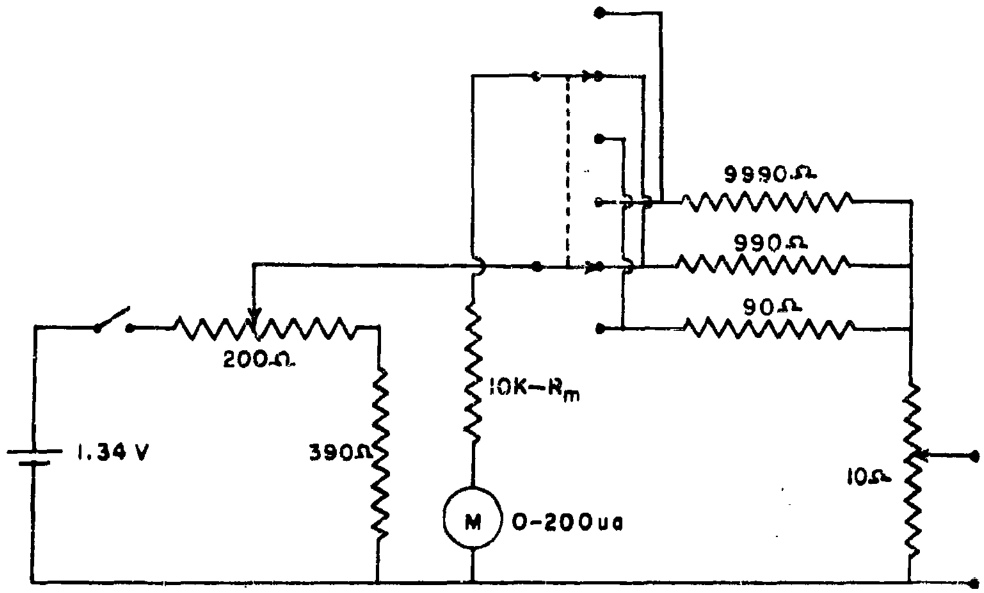


Figure 7.6 Calibrated d-c voltage source

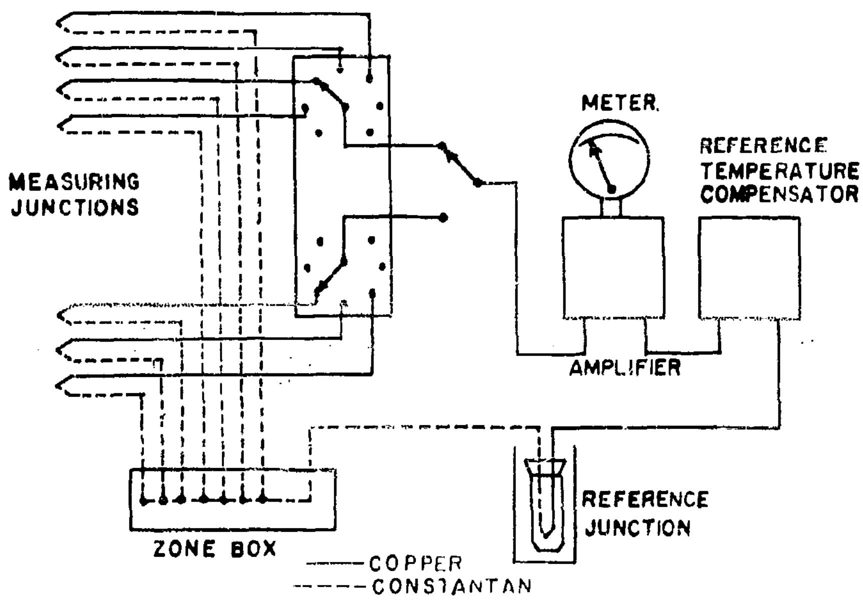


Figure 7.7 Temperature measuring system

output was obtained by means of an amplifier and recorder similar to that used for insolation measurements. Two recording scales were provided; -0.00125 to +0.005 cal $cm^{-2}sec^{-1}$, and -0.005 to +0.02 cal $cm^{-2}sec^{-1}$.

The calibration of this system was determined in the same manner as that of the insolation system.

7.3.4 Air and Soil Temperature Profiles All temperature measurements were made by means of copper-constantan thermocouples. The temperature measuring system (Figure 7.7) consisted of (a) shielded air temperature measuring junctions, (b) soil temperature measuring junctions, (c) measuring junction selector switches, (d) a modulated-carrier-type d-c amplifier, (e) a milliammeter, (f) a reference temperature compensator (calibrated microvolt source), (g) a constantan junction zone box, and (h) a reference junction.[2]

A radiation-shielded thermocouple assembly is shown in Figure 7.8. The shield consisted of four aluminum plates held together by small screws and plastic spacers. "Alzak" aluminum 0.032 inches thick was used for the shield plates because it is highly reflective in the portion of the spectrum between 0.4 and 7.5 microns. The thermocouple junction formed by No. 36 B&S gauge copper and constantan wire was positioned in the center space of the shield plate stack. The surfaces of the plates faced toward the junction were coated with flat black paint so that heat transfer by radiation would assist in keeping the shield stack at air temperature.

The lead wires were No. 16 B&S gauge rubber-covered copper and constantan in a twisted pair which was encased by a weather-proof neoprene covering.

Hollow brass tubes formed the supporting arms for the shield assembly. The lead wires entered the base fitting and the copper lead was threaded through one arm and the constantan through the other. As shown in Figure 7.8, the ends of the No. 36 B&S gauge copper and constantan wires which formed the junction were secured to the corresponding lead wires by means of firm-fitting plastic sleeves.

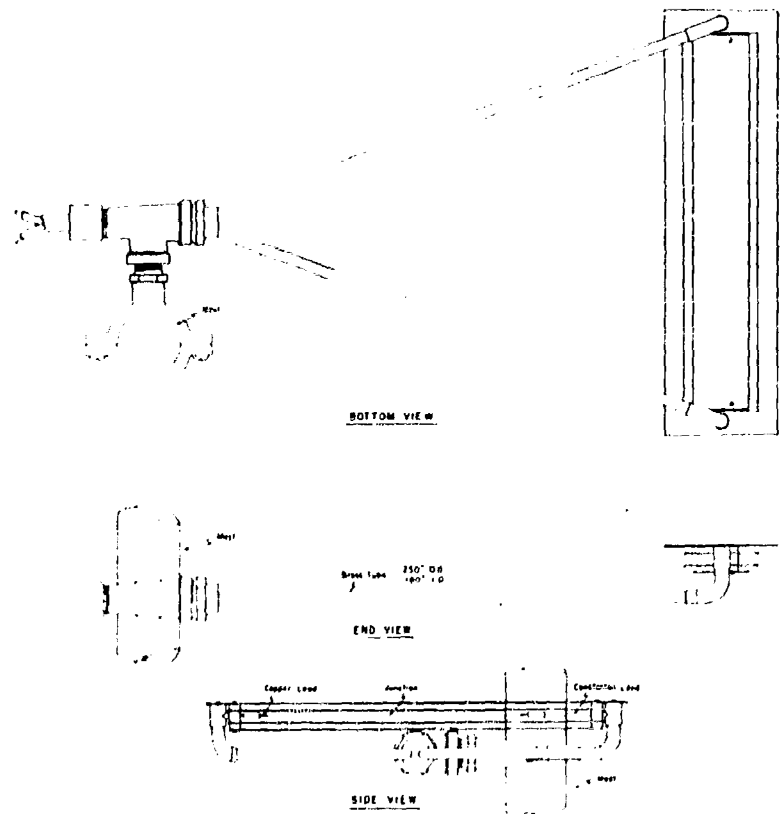


Figure 7.8 Shielded thermocouple assembly

The thermocouple junctions were made by tinning the ends of No. 36 B&S gauge copper and constantan wires, bringing them into end-to-end contact with the aid of a glass capillary tube, and soldering them.[8] Junctions formed in this manner are uniform and not significantly larger in diameter than the wires themselves. A thermocouple of this type has a low heat capacity and relatively low thermal conductivity.

A set of eight shielded thermocouple assemblies was used as shown in Figure 7.3. The supporting structures could be lowered to facilitate cleaning the shields and replacing the thermocouples.

The thermocouple measuring junctions used to obtain soil temperatures were of two types[4] as shown in Figure 7.9. The junctions which were placed at depths of 12.5, 25, 50, and 100 cm were formed by No. 16 B&S gauge copper and constantan lead wire. This type of junction was encased in a copper tube 6.5 inches long and 5/16-inch outside diameter. The copper tube was sealed at one end by a brass bullet-shaped cap. The junction was electrically insulated from the copper sheath by "Glyptal" lacquer and plastic tape. The junctions which were placed at depths of 3.125 and 6.25 cm were formed by No. 36 B&S gauge copper and constantan wires. The wires were insulated by means of thin glass capillary tubes and inserted in a brass sheath 6.5 inches long and 0.095 inches outside diameter. One end of the sheath was sealed by a pointed brass cap and the other end was connected to a 1.5-inch length of 5/16-inch outside diameter copper tubing which served as a housing for the splices of the No. 36 B&S gauge wires to No. 16 B&S gauge lead wires. The junction was electrically insulated from the sheath by "Glyptal" lacquer.

Care was taken during installation of the soil temperature elements to disturb as little as possible the soil which would surround the junctions. A triangular pit slightly more than one meter deep was excavated. The sod was cut and removed and successive layers of soil were removed and piled separately. In order to maintain accurate spacing between the junctions, a wooden template (5 cm × 2 cm × 105 cm) in which appropriate holes had been drilled was used. The wooden support was accurately positioned vertically at the apex of the pit. Holes which were slightly

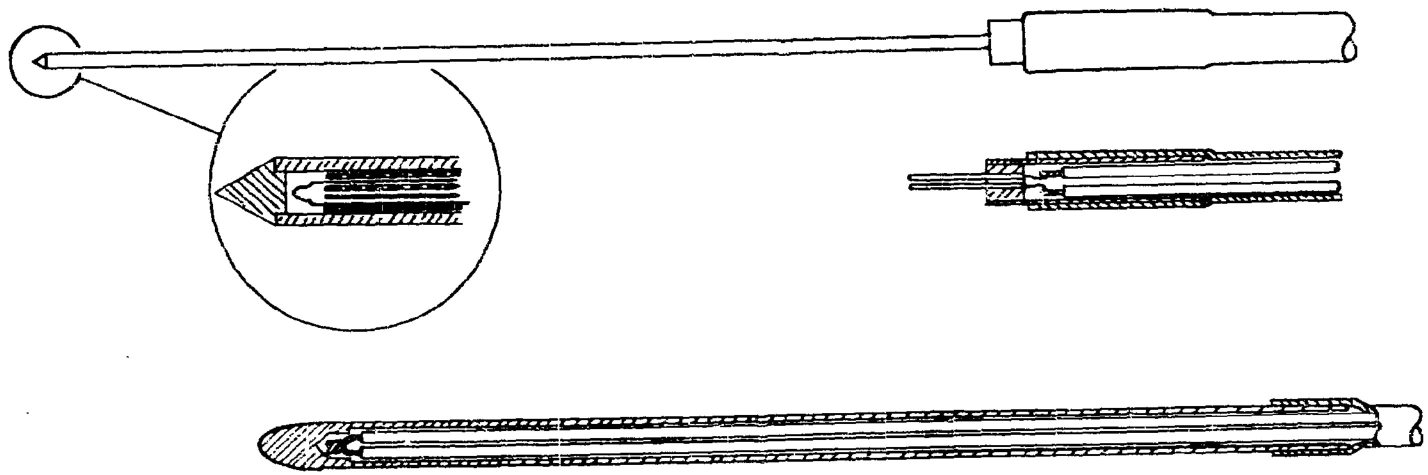


Figure 7.9 Soil temperature thermocouple elements

smaller in diameter than the temperature elements were drilled into the side of the pit at each level. The temperature elements were then inserted horizontally through the wooden support and into the holes in the soil. The layers of soil were replaced at their original depths as the pit was filled. To minimize the effect of thermal conduction along the lead wires, each lead was buried at the same depth as its corresponding element for a horizontal distance of approximately one meter from the element. Figure 7.10 illustrates the arrangement of the soil temperature measuring junctions.

All constantan leads from the measuring junctions were connected to the constantan lead to the reference junction at the constantan junction zone box. (See Figure 7.7) The lead ends were held in contact with the common lead by means of plastic clamps. Each lead could be easily disconnected from the circuit for checking purposes.

The copper leads from the measuring junctions were connected to the individual positions of a two-gang rotary selector switch. A copper knife switch permitted selection of a gang. Since the rotary selector switch had silver contacts, it was mounted in a thermos flask which insured isothermal conditions and prevented the occurrence of spurious voltages due to the copper-silver junctions.

The reference junction was formed by No. 16 B&S gauge copper and constantan wires and was electrically insulated and water-proofed by a thin coating of polyethelene. The reference junction was immersed in a pint thermos flask filled with a mixture of distilled water and crushed distilled water ice. To prevent conduction of heat to the junction by the lead wires, approximately one foot of the lead wires was looped and immersed with the junction. The thermos flask was mounted in a cork-lined metal container to further reduce the melting rate of the ice. The metal container was mounted near the floor on a pair of horizontal pivots. The operator could impart a rocking motion to the container with his foot. In this way the reference bath was agitated to minimize thermal stratification. The mixture of ice and water was assumed to be at 0°C.

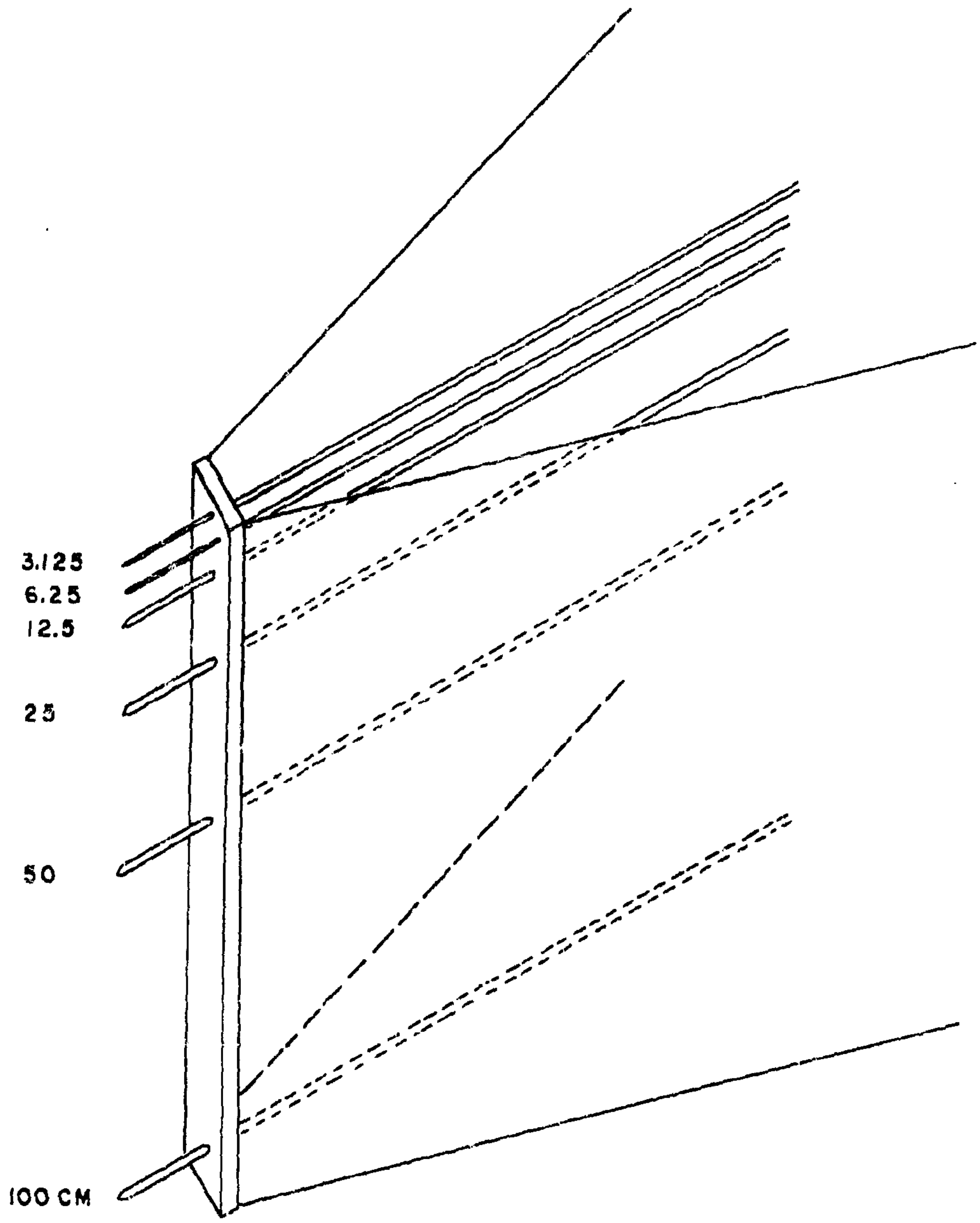


Figure 7.10 Installation of soil temperature elements

The circuit diagram for the modulated-carrier-type d-c amplifier is shown in Figure 7.11. The prominent characteristics of this amplifier are high sensitivity, virtually no zero drift, high gain stability, relatively high input impedance, and a high degree of linearity. The amplifier used for temperature measurements had a nominal input range of 0 to 400 microvolts which corresponds to the output of copper-constantan thermocouples for a 10°C temperature difference. A control was provided for precise setting of the amplifier gain.

The amplifier output was indicated on a meter (Weston, Model 271) which had a range of 0 to 1 milliampere and an internal resistance of 1400 ohms. The meter scale was 5.8 inches (147 mm) in length, had 100 divisions, and was marked to read a temperature range of 0° to 100°. This meter was equipped with a knife-edge pointer and a mirror scale which eliminated reading errors due to parallax.

The reference temperature compensator circuit is shown in Figure 7.12. This unit is a calibrated variable microvoltage source. By setting the dial of the 5000-ohm precision variable resistor and regulating the voltage across the precision divider consisting of the 1-ohm, 250-ohm, and nominal 5000-ohm series-connected resistors; a microvoltage equivalent to that produced by copper-constantan thermocouples for any temperature difference in the ranges of 0° to 45°C and 0° to 45°C could be obtained. In this circuit, the output microvoltage is made dependent only on the setting of the 5000-ohm resistor by maintaining a constant voltage across the divider. This is accomplished by comparing the voltage across the divider with the emf of a standard cell and varying the 100K ohm resistor in series with the 1.5-volt dry cell until a condition of balance is obtained as indicated by the microammeter.

Since the input range of the amplifier was limited to a 10°C increment and the reference thermocouple junction was maintained at 0°C, the reference temperature compensator was employed in measuring temperatures which exceeded 10°C. The connection of the compensator in the measuring circuit was such that its output voltage was subtracted from the voltage

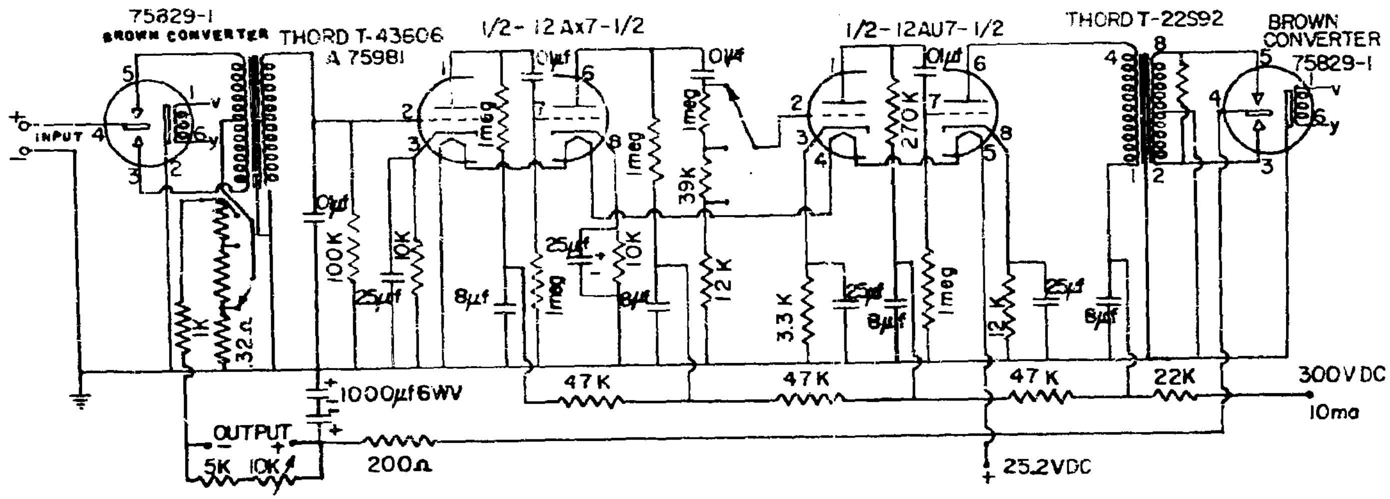


Figure 7.11 Thermocouple amplifier

produced by the thermocouples. The net voltage was then amplified and indicated on the meter. The following example illustrates the operation of the temperature measuring system:

To measure the temperature (assumed to be between 20° and 30°C) at the 50-cm depth in the soil:

(1) Set the selector switch for the -50 cm soil-measuring junction,
(2) Set the reference temperature compensator dial for 20°C compensation and adjust the balance control,
(3) Set the amplifier gain dial for the 20° to 30°C increment, and
(4) Read the meter (assume a reading of 6.35 is obtained)
(5) Apply a meter correction, in this case +0.02.

The temperature (26.37) is the compensation (20°C) plus the meter reading (6.35°C) plus the meter correction (+0.02).

A platinum resistance thermometer (Leeds and Northrup), which had been calibrated by the National Bureau of Standards, and a Mueller Bridge (Rubicon) were used to calibrate the copper-constantan thermocouple wire. A thermocouple circuit was constructed from a length of No. 16 B&S gauge copper-constantan lead wire. One junction was placed in a 0°C reference bath and the other junction was immersed in a large thermos flask filled with water (approximately five gallons). A Beckman differential thermometer and the resistance thermometer were immersed in this calibrating bath. The thermocouple junction, Beckman thermometer bulb and resistance thermometer bulb, were placed in close proximity near the center of the bath. A motor-driven stirring mechanism was used to agitate the water. The thermocouple wires were connected in a circuit with an amplifier, meter, and reference temperature compensator as shown in Figure 7.13. The amplifier and meter merely served as a sensitive null indicator, hence their calibrations had no influence on the wire calibration.

The temperature of the calibrating bath was varied through the range of -20°C to 50°C and 15 evenly-distributed calibrations points were obtained. Methanol antifreeze was added to the bath water for temperatures less than 0°C. The temperature of the bath was determined by the resistance

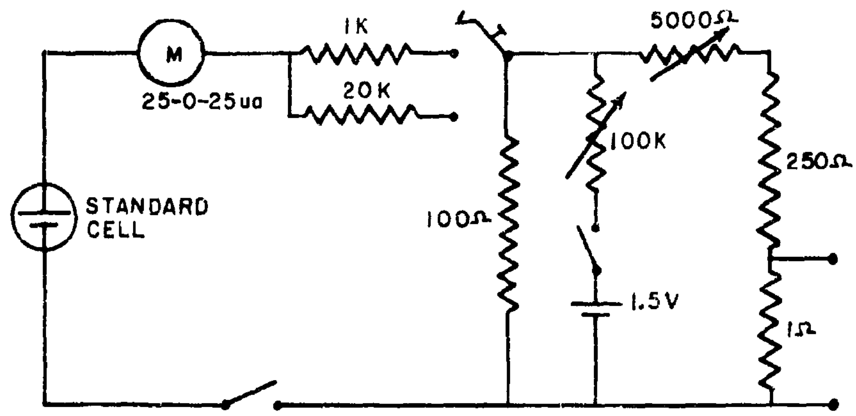


Figure 7.12 Reference temperature compensator

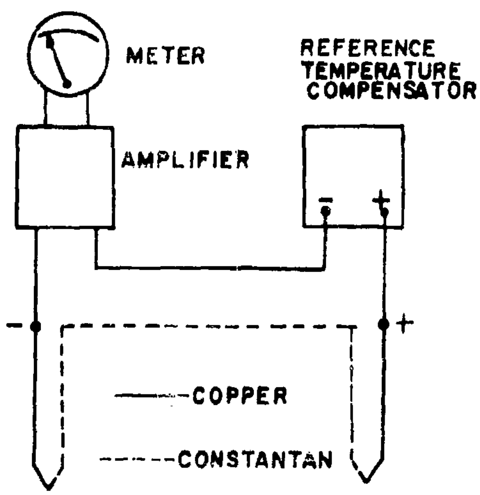


Figure 7.13 Thermocouple wire calibrating circuit

thermometer, and the rate of change of temperature was monitored by the Beckman differential thermometer. At each calibration point, a reference temperature compensator setting was determined which produced zero current flow in the measuring circuit as indicated by the amplifier meter null detector; that is, a setting was determined which caused the compensator output to be equal in magnitude to the emf produced by the thermocouple junctions. The emf temperature characteristic of the copper-constantan wire was then determined by measuring the output of the compensator for each of the dial settings. A potentiometer (Leeds and Northrup Type K), a precision voltage divider, an amplifier-meter null detector, and an auxiliary emf source were used for this measurement as shown in Figure 7.14. The amplifier and meter were calibrated by means of the circuit shown in Figure 7.15. In this circuit, the compensator serves as a calibrated microvoltage source which simulates the output of a thermocouple circuit. With the auxiliary microvoltage source set at zero output, the compensator was set for 10°C and the setting of the amplifier gain control which produced full-scale meter deflection was determined. The output of the auxiliary microvoltage source was then adjusted until it was equal in magnitude to the compensator output. Since the two microvoltage sources were connected so that their polarities were in opposition, a condition of equality was indicated by a reading of zero on the meter. (The zero reading, of course, is independent of the amplifier-meter calibration.) The setting of the compensator was then changed to 20°C and the amplifier gain setting for full-scale meter deflection was determined. The auxiliary microvoltage source was again adjusted for a condition of equality and the process was repeated. By this method, amplifier gain settings were established for a series of overlapping operating ranges, that is, 0° to 10°C, 5° to 15°C, 10° to 20°C, etc. The transfer characteristic of the amplifier-meter combination was determined and it was found that deviations from linearity were due primarily to meter movement and scale irregularities. Corrections to be applied to meter readings were established which corrected for the irregularities in the amplifier-meter transfer characteristic and the curvature of the emf temperature characteristic of the thermocouple wire.

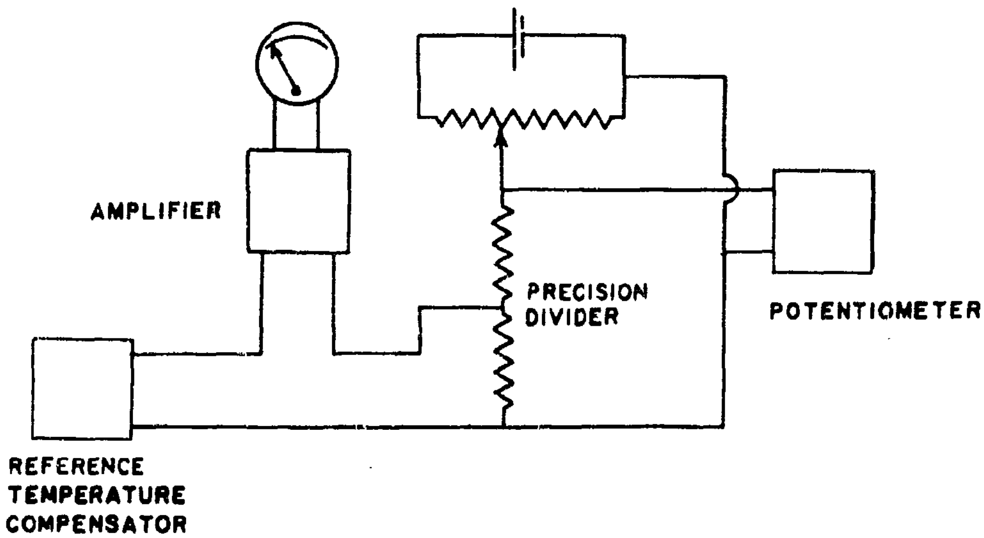


Figure 7.14 Calibrating circuit

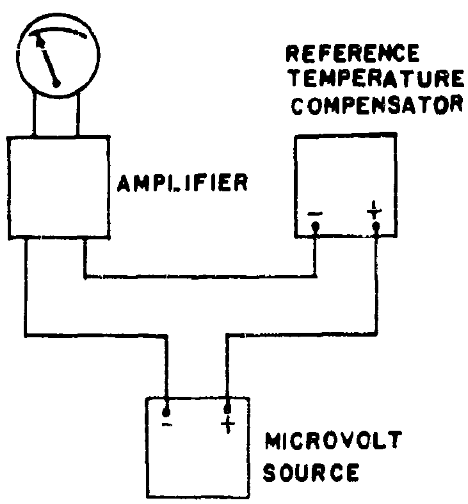


Figure 7.15 Amplifier calibrating circuit

The emf temperature characteristic of the No. 36 B&S gauge copper-constantan thermocouple wire had been established to be virtually the same as that of the No. 16 B&S gauge thermocouple wire by the Leeds and Northrup Company. This was verified by experimentation. A series circuit was constructed from lengths of No. 16 B&S gauge copper wire, No. 16 B&S gauge constantan wire, No. 36 B&S gauge copper wire, and No. 36 B&S gauge constantan wire.

Four junctions were formed: (1) No. 16 B&S gauge copper to No. 36 B&S gauge copper, (2) No. 36 B&S gauge copper to No. 36 B&S gauge constantan, (3) No. 36 B&S gauge constantan to No. 16 B&S gauge constantan and (4) No. 16 B&S gauge constantan to No. 16 B&S gauge copper. This circuit was connected to an amplifier-meter null detector. The No. 16 B&S gauge copper-constantan junction and the No. 36 B&S gauge copper-constantan junction were maintained at the same temperature by immersing them in a thermos flask filled with water. The No. 16 B&S gauge to No. 36 B&S gauge copper junction and constantan junction were heated separately. No thermoelectrical emf was obtained.

An overall statement of the accuracy of the temperature measurements cannot be made. The accuracy of the air temperature measurements is a function of the prevailing atmospheric conditions at the time the measurements were made. Errors inherent in thermal measurements further complicate an assessment of accuracy. It is possible, however, to designate the sources of error and to estimate, in some cases, the magnitude.

Absolute accuracy can be defined as the deviation of a measurement from true temperature. Relative accuracy can be defined as the deviation of a measured difference from true temperature difference. The significant errors in air temperature measurements are calibration error, radiation error, and sampling error.

The calibration of the thermocouple wire is the basis of the calibration of the temperature measuring system. The accuracy of the wire calibration is difficult to evaluate. However, the calibration was conducted with extreme care and several determinations of each measured value

showed the calibration to be reproducible. A conservative estimate of the error due to calibration inaccuracies is 0.05°C for an absolute measurement and 0.02°C for a relative measurement. Error caused by loss of calibration due to change in characteristics of the system components (in particular, a change in the emf temperature characteristic of the thermocouple wire) can be considered insignificant. A comparison of this wire calibration (conducted in April 1956) with a calibration conducted in May 1953 shows an average difference of 0.05°C. An unknown fraction (believed to be small) of this difference is probably due to a change in the emf temperature characteristic of the wire. Frequent checks of the amplifier calibration were made by the method illustrated in Figure 7.15 to insure no loss in accuracy due to this component.

Probably the most detrimental effect on the accuracy of the air temperature measurements was produced by radiative transfer at the measuring junctions. The magnitude of the radiation error is difficult to determine since it is a function of atmospheric conditions, time, height, and vertical distribution of wind velocity. In the daytime with a clear sky and low wind velocity this error would be greatest. All measured air temperatures would be higher than true air temperature. Air movement decreases the effect of radiation. The measurement nearest the ground would have the greatest error since the wind speed there is less than the wind speed aloft. At night with a clear sky the radiation error would produce measured temperatures lower than real, and variable with height and wind speed. Under cloudy and windy conditions, the radiation error would be less significant. Under isothermal conditions with zero net radiation at the surface, the radiation error would be completely absent. It is conceivable that the radiation error could be as high as 2°C; however, for most of the observations made at O'Neill it probably did not exceed 0.1°C.

A handy means of checking the relative accuracy of air temperature measurements independent of sampling error makes use of Nature's heat bath which exists with adiabatic thermal stratification. At these times, the thermocouples on the mast are exposed to the same constant potential

temperature.* That is, since the potential temperature is constant throughout the depth of measurement, and over the time of measurement, no breath of air of different potential temperature can come along to introduce sampling error. Since meteorological sampling error is missing, only radiational error and calibration error remain.

Adiabatic thermal stratification near the ground occurs typically twice a day, shortly after sunrise and a while before sunset. However, these are also times of rapid heating in the morning and cooling in the afternoon, so that the length of time that adiabatic stratification exists may be very short. On some occasions the entire 16-meter depth of measurement will not be at uniform potential temperature at any one time. Adiabatic profiles may be caused at other times by high turbulence if the turbulent heat flux is relatively small.

Analyses were made of six adiabatic or nearly adiabatic air temperature profiles (20-minute periods) obtained during the 3-day observation period 6-9 August 1956. Profiles of mean temperature and mean potential temperature were plotted for each of the six runs (see Figures 7.16, 7.17, 7.18, 7.19, 7.20 and 7.21). It was assumed that the logarithmic profile equation holds:

$$\theta = \theta_o + n\Delta\theta ,$$

where $\Delta\theta$ does not vary with height in the lowest 16 meters. Logarithmic profiles were fitted-by-eye, and the standard error of mean potential temperature for the 20-minute period was estimated as 1.25 times the average deviation of the points from the fitted line. The values are given in Table 7.1. This standard error ranges from 0.0048°C to 0.031°C, with an average value of 0.020°C. Since some meteorological sampling

*More precisely, to the same value of $\theta = T + \frac{g}{C_p} z$ where z is measured from the surface of the ground.

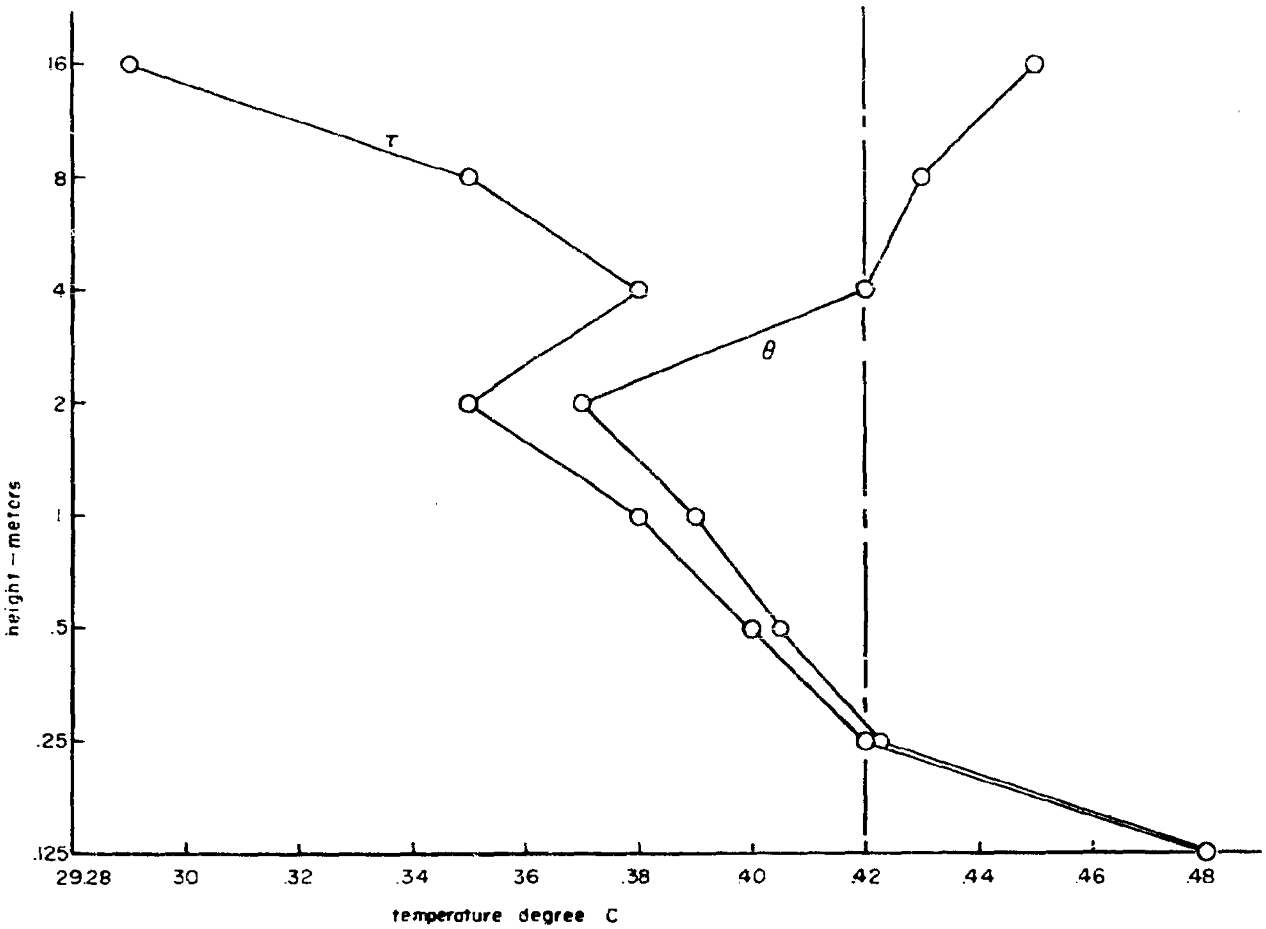


Figure 7.16 Twenty-minute profiles of temperature and potential temperature for conditions of nearly adiabatic stratification, 6 August 1956, 1805 CST

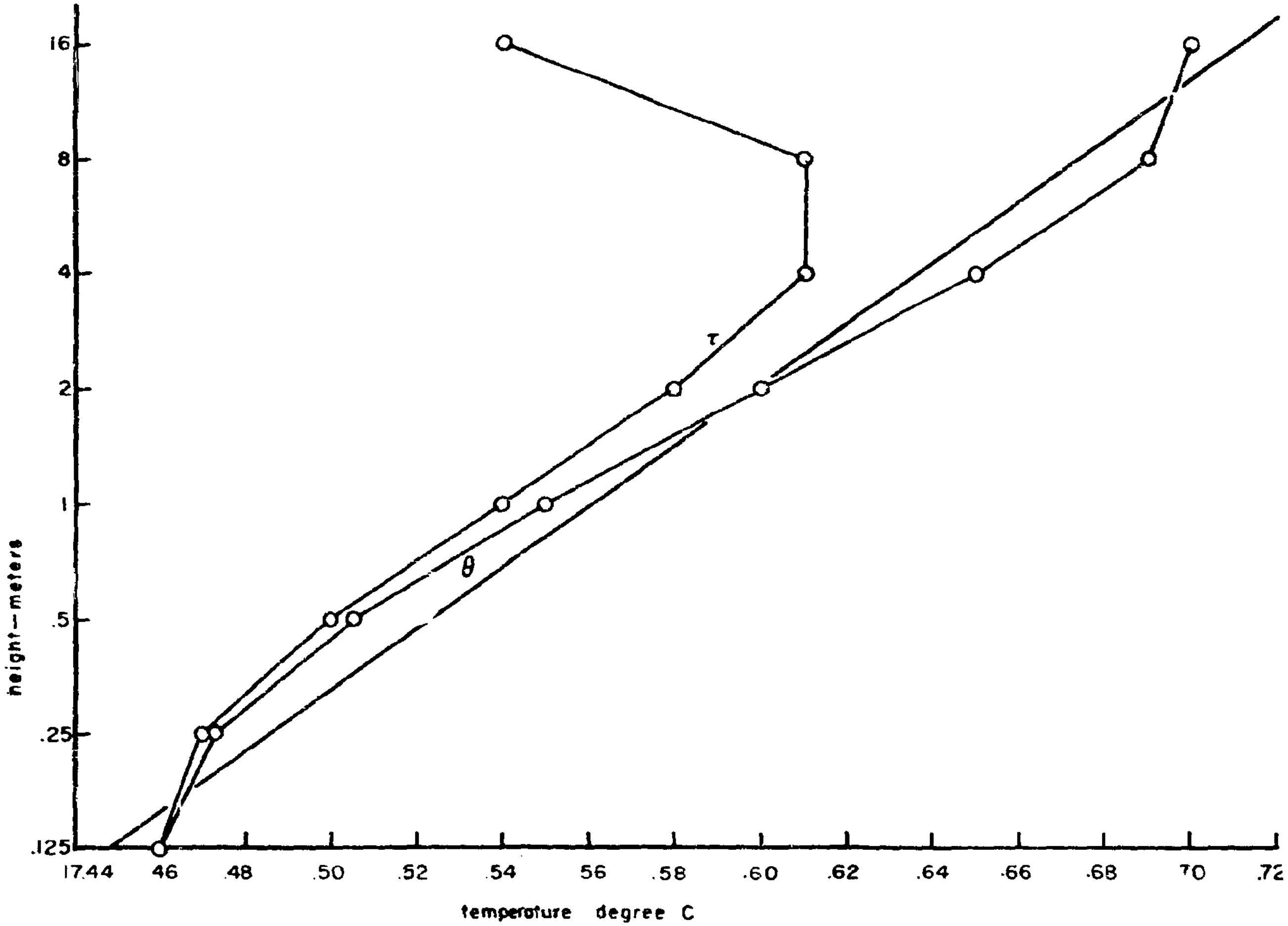


Figure 7.17 Twenty-minute profiles of temperature and potential temperature for conditions of nearly adiabatic stratification, 7 August 1956, 0305 CST

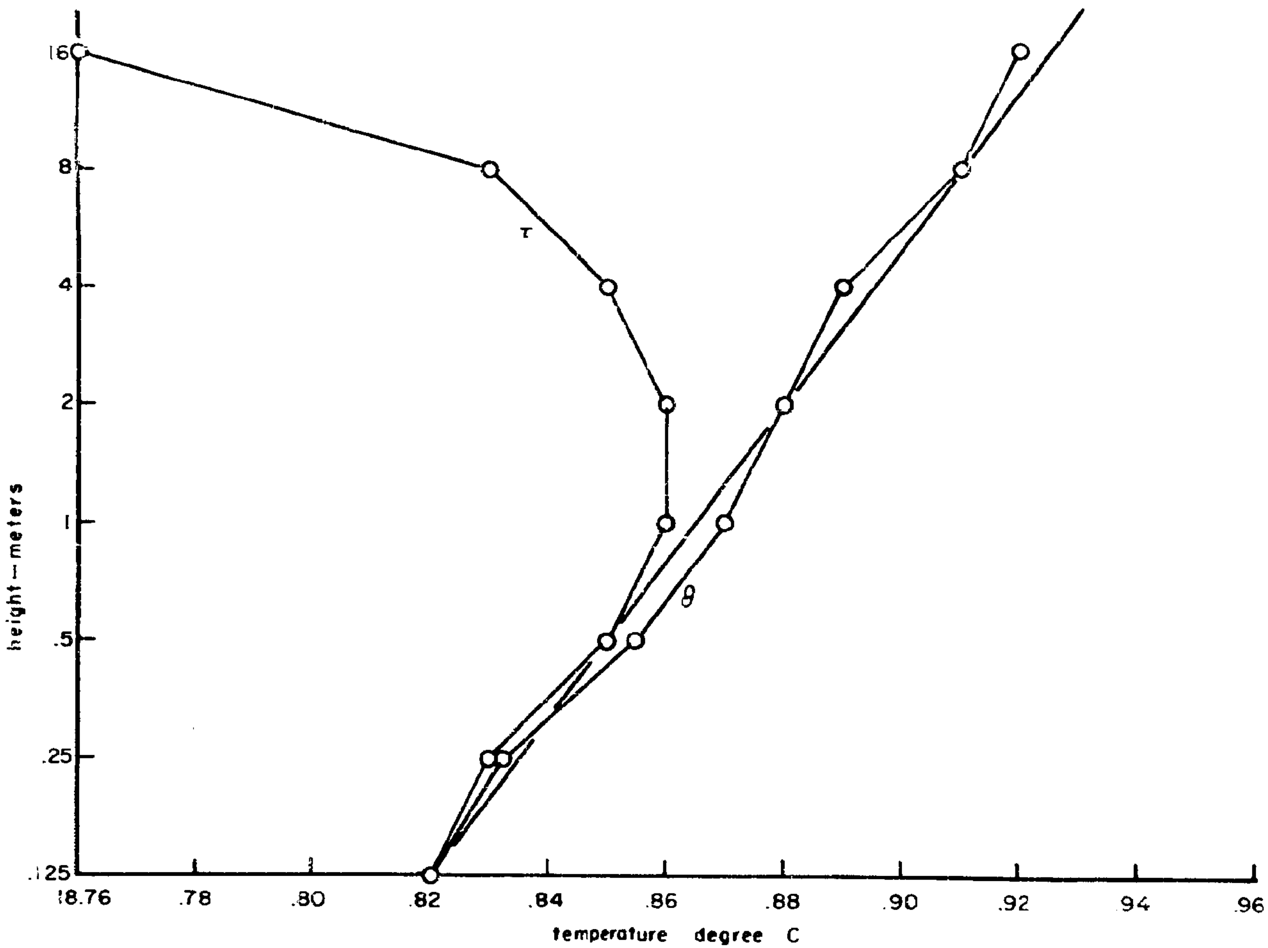


Figure 7.18 Twenty-minute profiles of temperature and potential temperature for conditions of nearly adiabatic stratification, 8 August 1956, 0205 CST

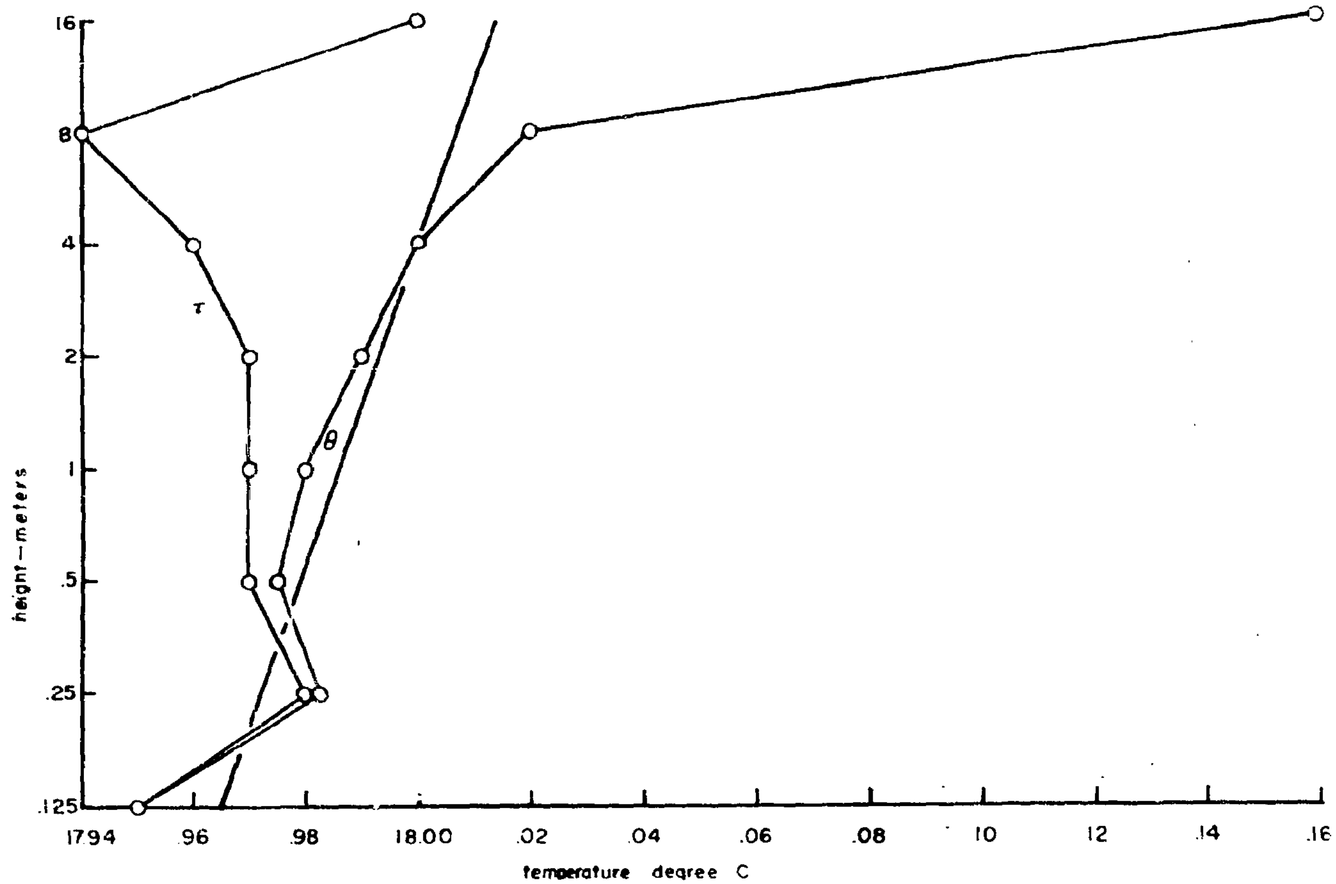


Figure 7.19 Twenty-minute profiles of temperature and potential temperature for conditions of nearly adiabatic stratification, 8 August 1956, 0805 CST

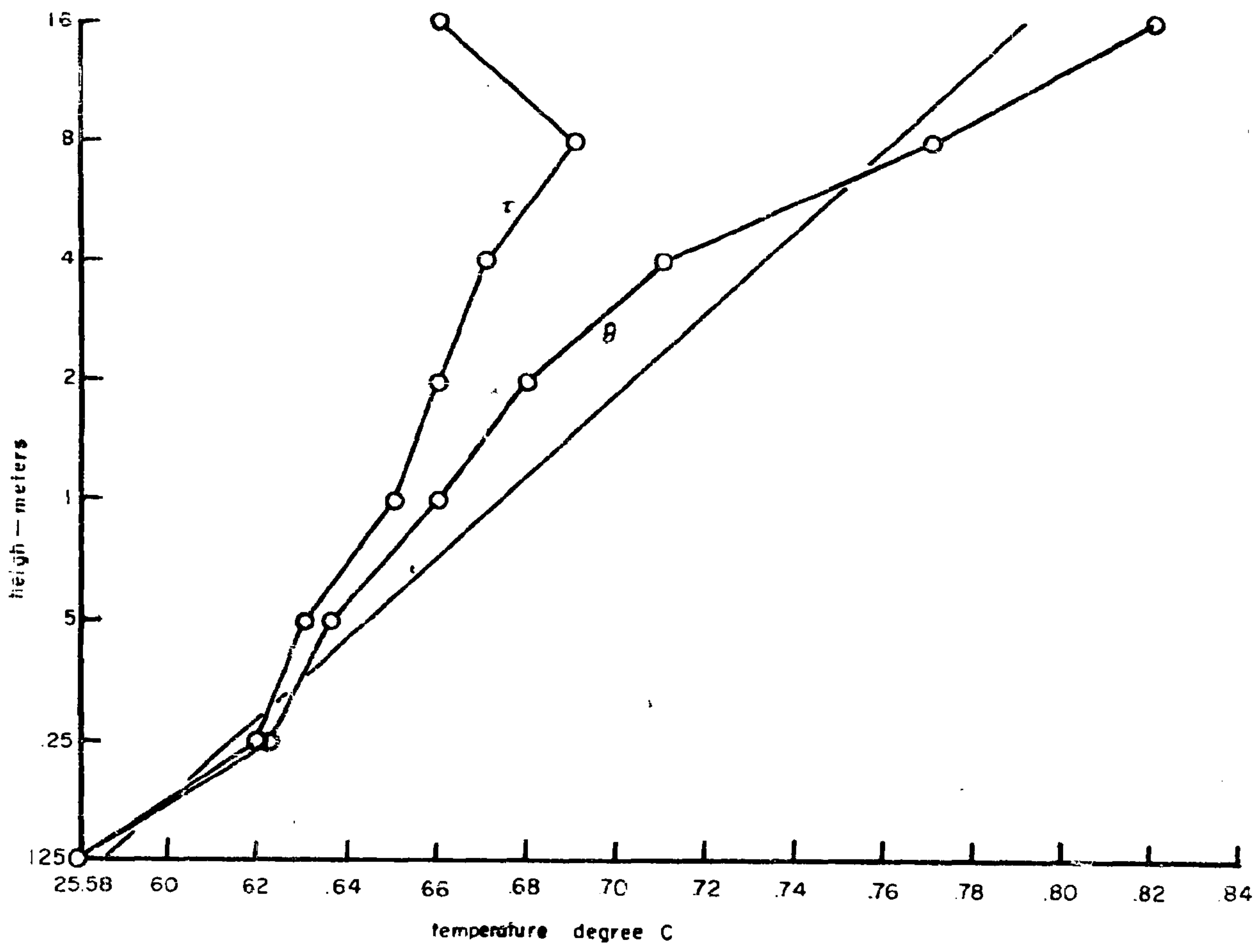


Figure 7.20 Twenty-minute profiles of temperature and potential temperature for conditions of nearly adiabatic stratification, 8 August 1956, 1905 CST

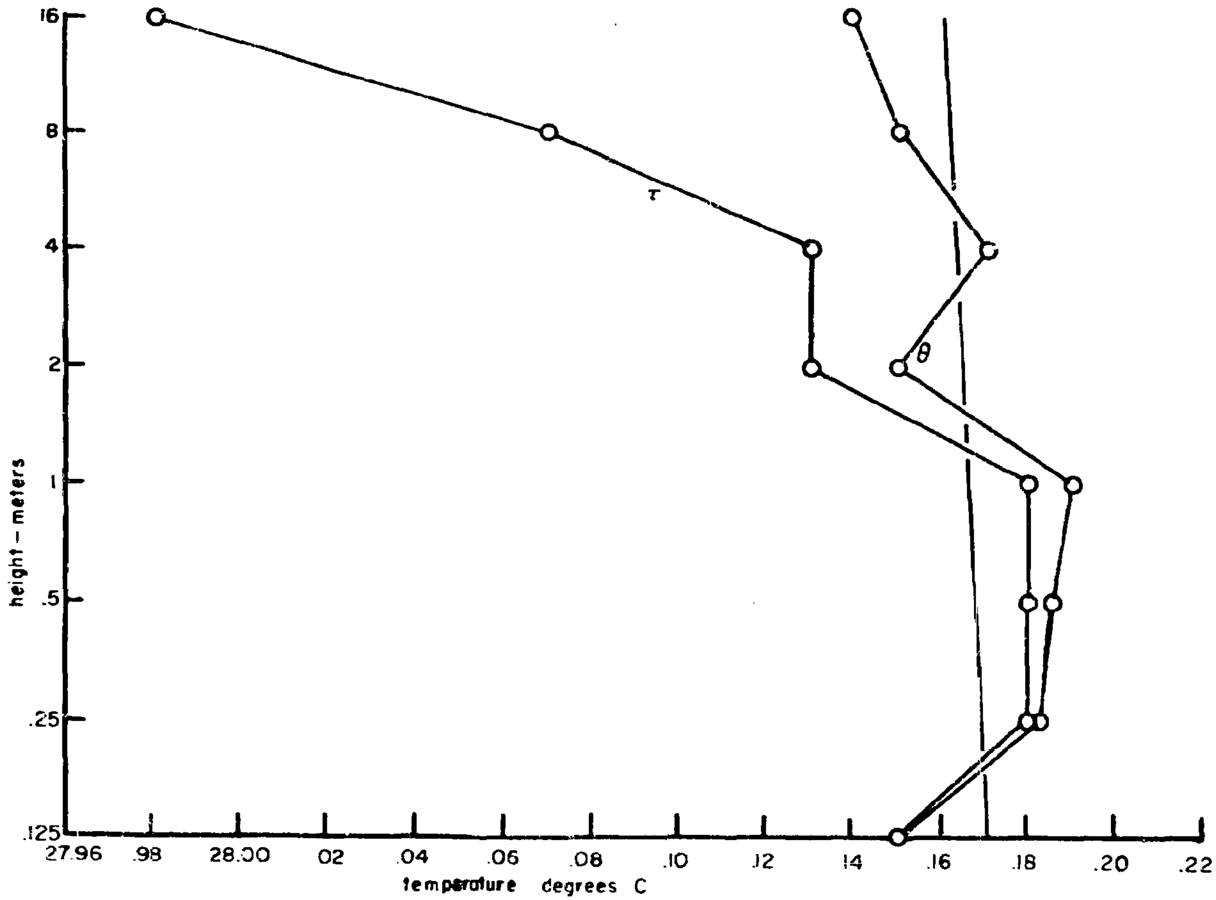


Figure 7.21 Twenty-minute profiles of temperature and potential temperature for conditions of nearly adiabatic stratification, 9 August 1956, 1705 CST

error still exists, and possibly a very small radiational error, these values are considered outside limits for the calibration standard error.

Table 7.1 Values of standard error of mean potential temperature

Date	Time	Type	$\Delta\theta$* (°C)	Wind Velocity Speed (cm/sec)	Dir (deg)	$S.E._T$ (°C)	Remarks
6 Aug	1755-1805	Cooling	.00	537	160	.031	.1 Cs
7 Aug	0255-0315	Dynamic	.04	574	65	.016	.4 low cloud Was raining previous two hrs
8 Aug	0155-0205	Dynamic	.015	812	20	.0048	Thunderstorms to north last few hrs
8 Aug	0755-0805	Warming	.01	314	330	.030	Overcast Raining one hr. ago
8 Aug	1855-1905	Cooling	.03	527	0	.017	.2 Cu
9 Aug	1655-1705	Cooling	.002	416	30	.019	Huge thunder-storm to west, advancing on us for last 3 hrs

* $\Delta\theta = \frac{\partial\theta}{\partial n}$, where n ("number of doubled levels") is the logarithmic, non-dimensional height scale $n = \frac{\ln z/z_0}{\ln 2}$.

The importance of the meteorological sampling error still remaining can be appreciated by taking a closer look at the data for two of the runs: that of 0205 CST on 8 August, an ideal case, and that of 1805 CST on 6 August, a less than ideal case. The thing sought is the nature of trends during the 20-minute periods. To this end, simplified profiles of potential temperature for the first and last five minutes of each run were obtained. The data of the lowest two heights, middle two heights, and top two heights were combined, giving profiles of only three points. These profiles are plotted in Figures 7.22 and 7.23. The latter 20-minute profile was obtained when shelter-height temperature dropped 1.0°C in 15 minutes, and the potential temperature profile quickly passed from daytime type to nighttime type during the run.

On the other hand, the ideal 20-minute profile was obtained with high turbulent mixing and small, nearly constant, heat flux downward. The drop in shelter-height temperature was only 0.4°C in 15 minutes, and the slope of the potential temperature profiles changed very little during the run. Meteorological sampling error was therefore much less in this period of observation than in that of 1805 CST on 6 August 1956.

Errors in the 20-minute profiles of mean temperature due to sampling may be evaluated by simple statistical techniques. The magnitude of these errors is least (nearly zero) when thermal stratification is adiabatic. It is also usually small with calm conditions at night. These errors are greatest in the heat of the day when no steady breeze is blowing.

A computation was made to evaluate sampling error in the temperature profiles. Data are from the 1455-1515 observation period of 8 August. This was a time of strong solar heating (clear sky above, bank of cumulus clouds in the distant southeast) and "very light" winds from the southwest. In the computations, the standard deviations are in all cases estimated at 5/4 of the average deviation.

The standard deviation of the 20 temperature measurements at each height varied from 1.06 degrees ($Z = 0.125$ m) to 0.44 degrees ($Z = 16$ m). Since the serial correlation is negligible, the standard error of the mean temperature is $(1/20)^{1/2}$ times the standard deviation. The mean

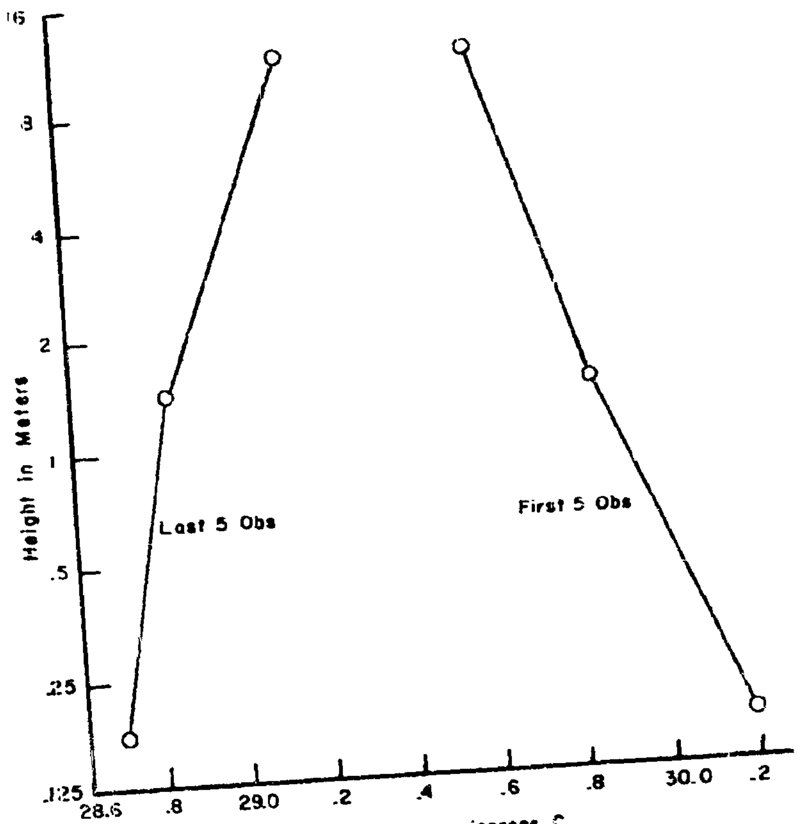


Figure 7.22 Temperature profile, 6 August 1956, 1805 CST

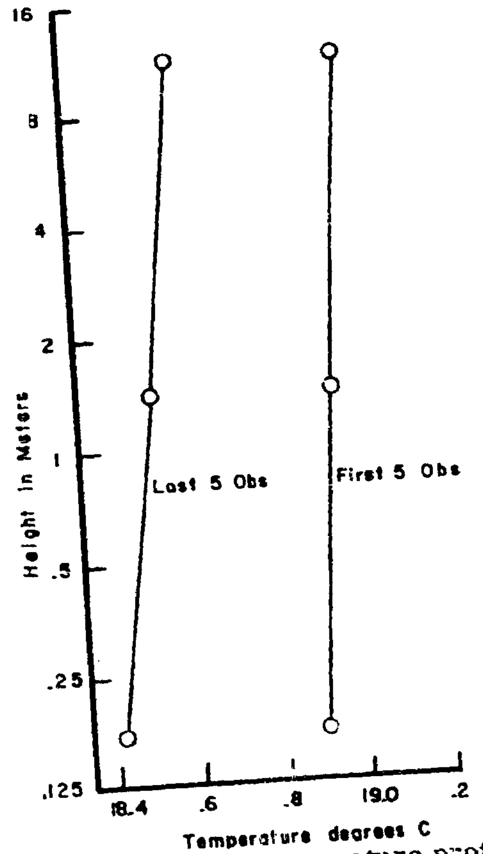


Figure 7.23 Temperature profile, 8 August 1956, 0205 CST

temperatures at the various heights are found to have standard errors of 0.10 to 0.24 degrees. Figure 7.24 shows the profile of $\bar{T}$ plus or minus S.E.$_{\bar{T}}$ as a function of height.

The accuracy of mean temperature differences within the profile is increased by a small positive correlation between temperature observations at various heights. In this example, the difference in mean temperature at 1 m height and at all other heights is between 0.18 degrees and 0.24 degrees.

The means, standard deviations, and correlation coefficients are given in Table 7.2.

Table 7.2. Statistical measures of temperature

Height (Cm)	$\bar{T}$	σ_T	S.E.$_{\bar{T}}$	$\bar{T}_z-\bar{T}_{1m}$	$\sigma(T_z-T_{1m})$	SE$(\bar{T}_z-\bar{T}_{1m})$	*	$r(T_z, T_{1m})$
1600	28.86	0.44	0.10	-1.83	0.93	0.21	0.20	-.044
800	29.37	.57	.13	-1.32	.92	.21	.22	+.13
400	29.76	.75	.17	-0.93	.91	.20	.25	+.31
200	30.31	.68	.15	-0.38	.91	.20	.23	+.25
100	30.69	.80	.18					
50	31.40	.93	.21	+0.71	0.82	.18	.27	+.56
25	32.54	0.92	.21	+1.85	1.06	.24	.27	+.25
12	33.55	1.06	0.24	+2.86	1.03	0.23	0.30	+.41

* - Value that S.E.(T_z-T_{1m}) would have if correlation were zero.

$$\bar{T} = \frac{1}{N} \sum_{i=1}^{N} T_i$$

$$\sigma_T^2 = \frac{1}{N} \sum_{i=1}^{N} (T_i-\bar{T})^2 \; ; \qquad \sigma_T = \frac{5}{4} \frac{1}{\sqrt{N}} \sum_{i=1}^{N} |T_i-\bar{T}|$$

$$S.E._T = \frac{1}{\sqrt{N}} \sigma_T$$

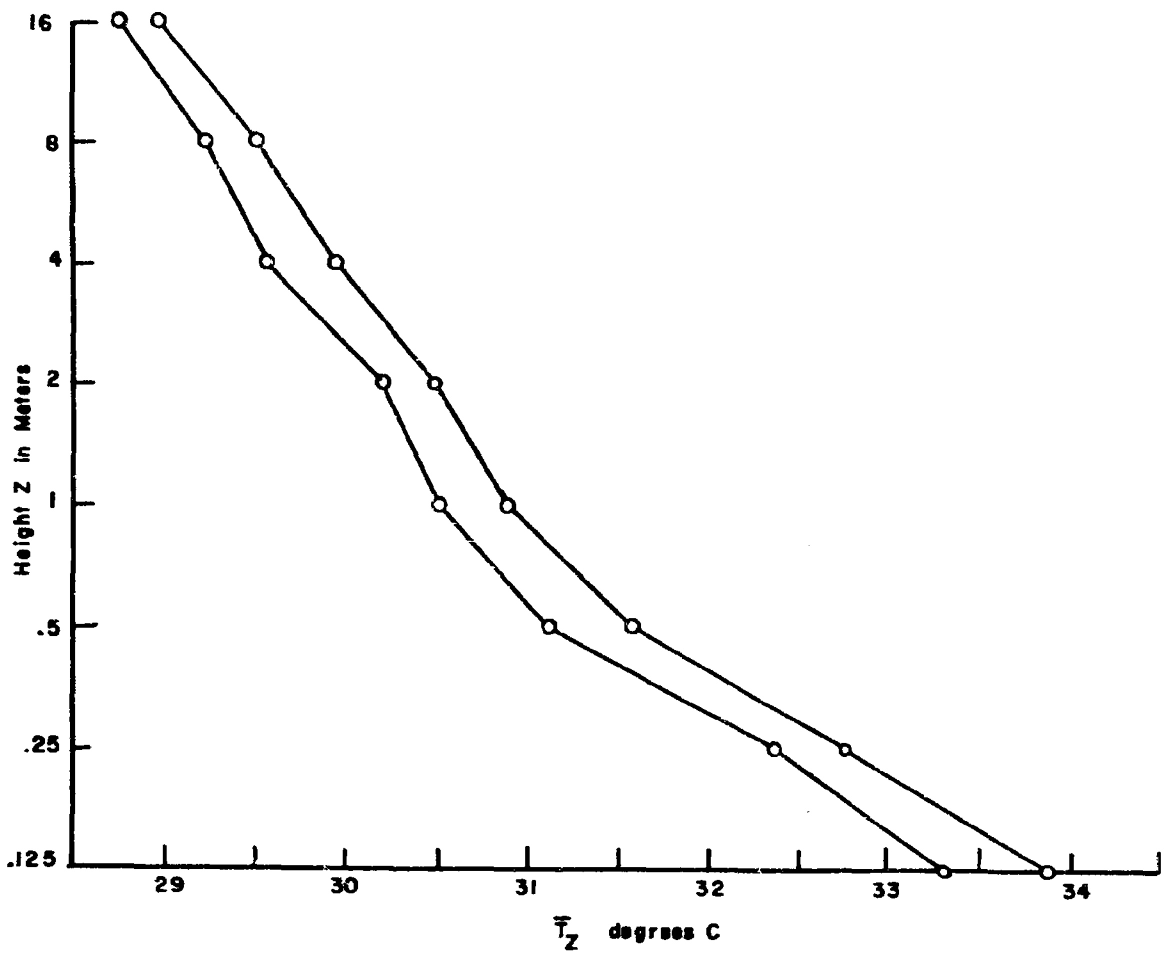


Figure 7.24 Mean temperature plus or minus its standard error, 8 August 1956, 1505 CST

$$\sigma^2_{(T_z - T_{lm})} = \frac{1}{N} \sum_{i=1}^{N} \left[(T_z - T_{lm}) - (\bar{T}_z - \bar{T}_{lm}) \right]^2$$

$$S.E._{(\bar{T}_z - \bar{T}_{lm})} = \frac{1}{\sqrt{N}} \sigma_{(T_z - T_{lm})}$$

$$\sigma^2_{(T_z - T_{lm})} = \sigma^2_{T_z} + \sigma^2_{T_{lm}} - 2r_{(T_z, T_{lm})} \sigma_{T_z} \sigma_{T_{lm}}$$

The accuracy of the soil temperature measurements is 0.05°C for absolute measurements and 0.02°C for relative measurements since the only significant error is that due to calibration inaccuracy.

Malfunctioning of the temperature measuring system could be easily recognized by observing the hourly change in temperature at the 1-meter depth in the soil. Large scale change or rapid fluctuations in this reading usually indicated shorts or leakage to ground, electric and magnetic field pickup, or component failures. Difficulties could also be recognized by reading the 1-meter soil temperature using two overlapping reference temperature compensator ranges.

7.3.5 Air Temperature Difference. The air temperature difference between the 1-meter and the 1/2-meter levels was measured by means of two radiation-shielded thermocouple junctions of the same type as that used for air temperature profile measurements. The two junctions were differentially connected and the output was recorded by a modulated-carrier-type d-c amplifier and an Esterline-Angus graphic ammeter.

A recording scale of -5° to +5°C was used; hence, the temperature at one level relative to the other was determined in addition to the temperature difference.

7.3.6 Vapor Pressure Profiles. The measurement of the amount of water vapor in the air was accomplished by means of an air sampling system and a dew-point hygrometer. During the 20-minute observation periods, air samples were obtained at each level as shown in Figure 7.3.

The dew point of each sample was then measured using a Thornthwaite automatic dew-point hygrometer.[6] The data reported are in units of vapor pressure (millibars) which were obtained by conversion of the measured data which were in terms of dew-point temperature (degrees Centigrade).

The air sampling system shown schematically in Figure 7.25 consisted of (a) polyethylene sampling tubes, (b) sample storage jugs, (c) sample selector valves, (d) a variable speed pump, and (e) a pump speed control. Polyethylene tubing having an inside diameter of 0.25-in. was used since this material is virtually non-hygroscopic. One gallon glass jugs were used as reservoirs for the air samples in order to obtain average samples(that is, samples which did not exhibit small scale fluctuations) simultaneously from all levels. The sample selector valves permitted extraction of the samples from the reservoirs for measurement. A modified vacuum cleaner was used as an air pump. The rate of pumping could be changed by varying the input voltage to the pump motor. Two pump speeds were used and were conveniently obtained by switching the motor input to full line voltage or to the voltage at a tap on an auto-transformer.

The dew-point hygrometer is shown in Figure 7.26. This is a condensation type hygrometer which utilizes a mirror surface on which moisture is caused to condense. By measuring the temperature of the mirror at the time of incipient condensation the dew point is obtained.

The instrument which was used consisted of (a) a mirror assembly, (b) a sample chamber, (c) a photoelectric dew-film detection system, (d) a dry-ice heat sink, (e) a control circuit, and (f) a radio frequency induction-heating unit. The mirror assembly was formed by copper foil chrome plated on one surface and soldered to the end of a steel rod 0.25-in. in diameter which, in turn, was connected to a copper slug 1-inch in diameter and 5 inches long. The chrome surface served as the mirror and a copper-constantan thermocouple junction was held in contact with the under or copper surface by a second piece of copper foil. This junction

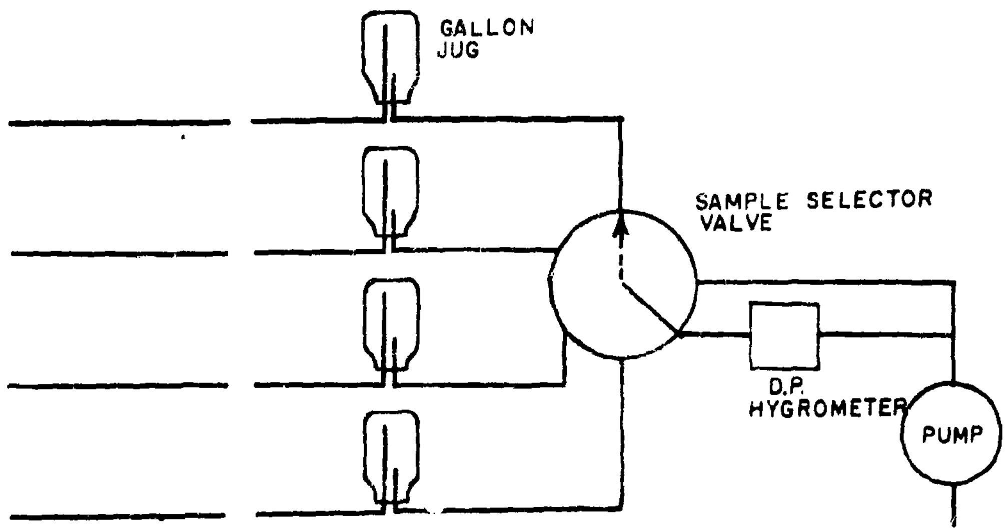


Figure 7.25 Air sampling system

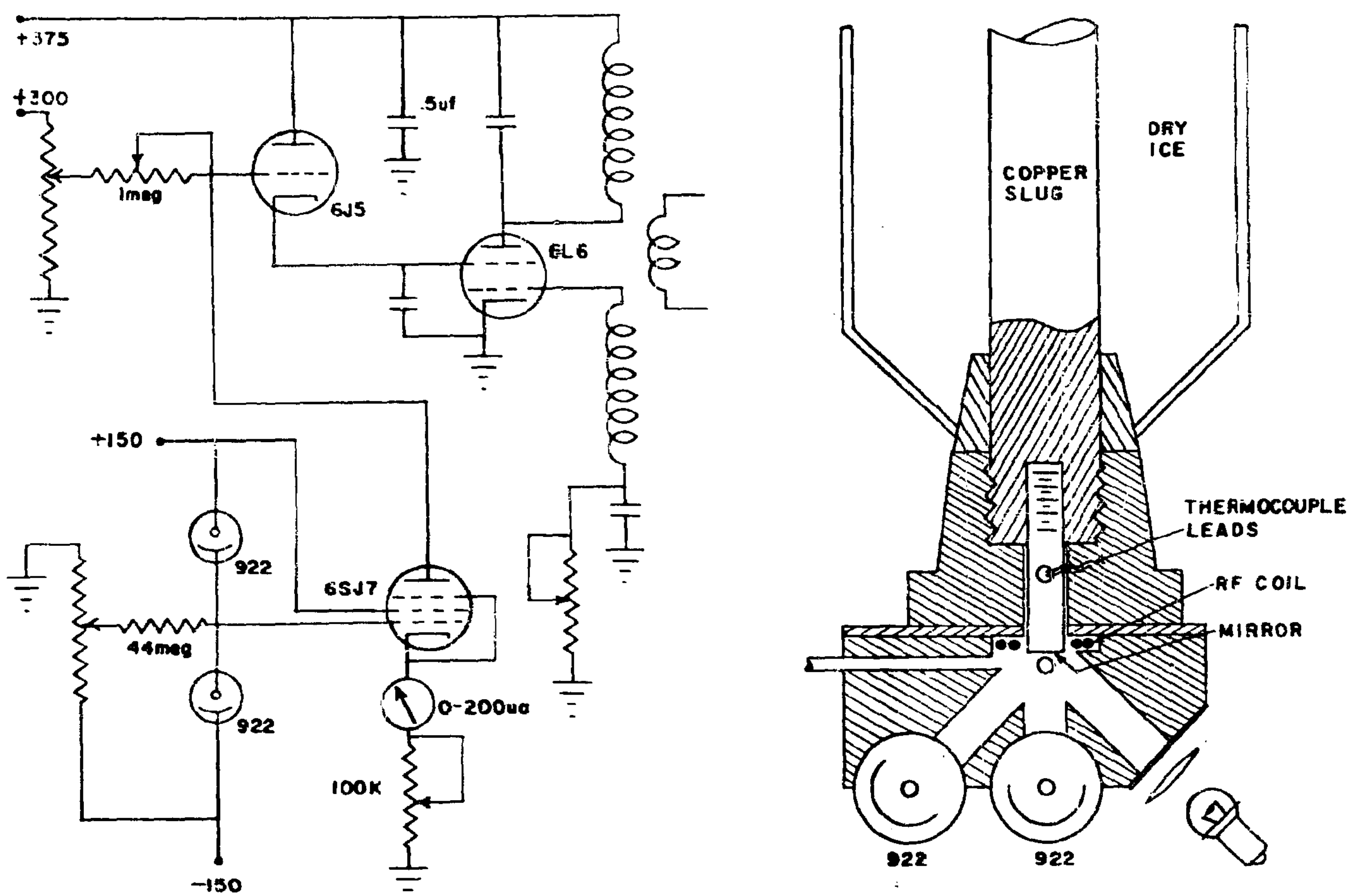


Figure 7.26 Dew point hygrometer

was connected to the temperature measuring system (see Figure 7.7). The thermocouple wire was the same type, No. 36 B&S gauge, as that used for the air temperature measuring junctions.

The copper slug of the mirror assembly was inserted in a thermos flask filled with crushed dry ice and the steel mirror stem was inserted in a hole in the sample chamber. A radio frequency induction heating coil concentric with the hole in the sample chamber then encircled the steel mirror stem. The sample chamber was a hollow, airtight, plastic block with air sample intake and exhaust ports, windows for two photocells, and a window for the admission of a light beam.

The photoelectric dew-film detection system was connected to an amplifier (control circuit) which, in turn, controlled a radio frequency oscillator (R-F induction heating unit).

In operation the mirror surface was cooled by the dry ice and heated by the R-F induction heater. By controlling the heating, the mirror temperature could be varied. Three heat controls were available: (1) a quick-heat button, (2) a manual control, and (3) an automatic control. By manually depressing the quick-heat button, rapid heating of the mirror was obtained. The manual control enabled the operator to vary the mirror temperature to obtain a dew-film of proper thickness. The automatic control was provided by the photoelectric dew-film detection system. Light which was incident at an angle of 45 degrees on the mirror was reflected to one photocell. A second photocell positioned directly below the mirror surface(that is, on a line normal to the mirror surface) received scattered light when a dew-film was present. An increase in dew-film thickness caused a decrease in reflected light and an increase in scattered light. This change was sensed by the photocells which produced a control voltage causing an increase in R-F induction heating. Conversely a decrease in dew-film thickness was sensed and the heat supply to the mirror decreased. In this way the automatic control aided the operator in maintaining a constant dew-film thickness on the mirror.

In addition to providing automatic control, the photoelectric dew-film detection system produced a meter indication of dew-film thickness. The dew-film thickness meter permitted establishing a standard dew-film thickness for all measurements.

The following procedure was used for measuring dew-point profiles. With the sample selector valves set in the simultaneous sample position and the pump set for high speed, air samples were drawn into the storage jugs. The pump was set for low speed and the valves were set so that air which was a mixture of all the samples was passed through the sample chamber. In this way an initial setting of the manual control was made to produce a dew-film and the proper reference temperature compensator range setting was determined for the temperature measuring system. The quick-heat button was then depressed to clear the dew-film from the mirror and the zero or clear mirror reading of the dew-film thickness meter was checked. Valve settings were made for selection of the first sample. The pump was operated at high speed for 3 to 5 seconds to scavenge the sample chamber and connecting tubes of the initial air. With the pump operating at low speed, the manual control was set to produce a dew-film of the proper thickness as indicated by the dew-film thickness meter. The temperature of the mirror was then read by means of the temperature measuring system. The second sample was selected and the first sample scavenged by operating the pump at high speed. The process was then repeated. Slow speed operation of the pump during the measuring period was necessary to prevent depletion of the air sample and mechanical disturbance of the dew-film by the air passing over its surface.

Because of the number of manual adjustments and switch settings, and complexity of the procedure, considerable skill was required of the operator in measuring dew-point profiles.

Prior to Project Prairie Grass, the dew-point hygrometer was calibrated by an air saturating chamber as shown in Figure 7.27. The chamber was formed by two sheet-copper boxes one within the other

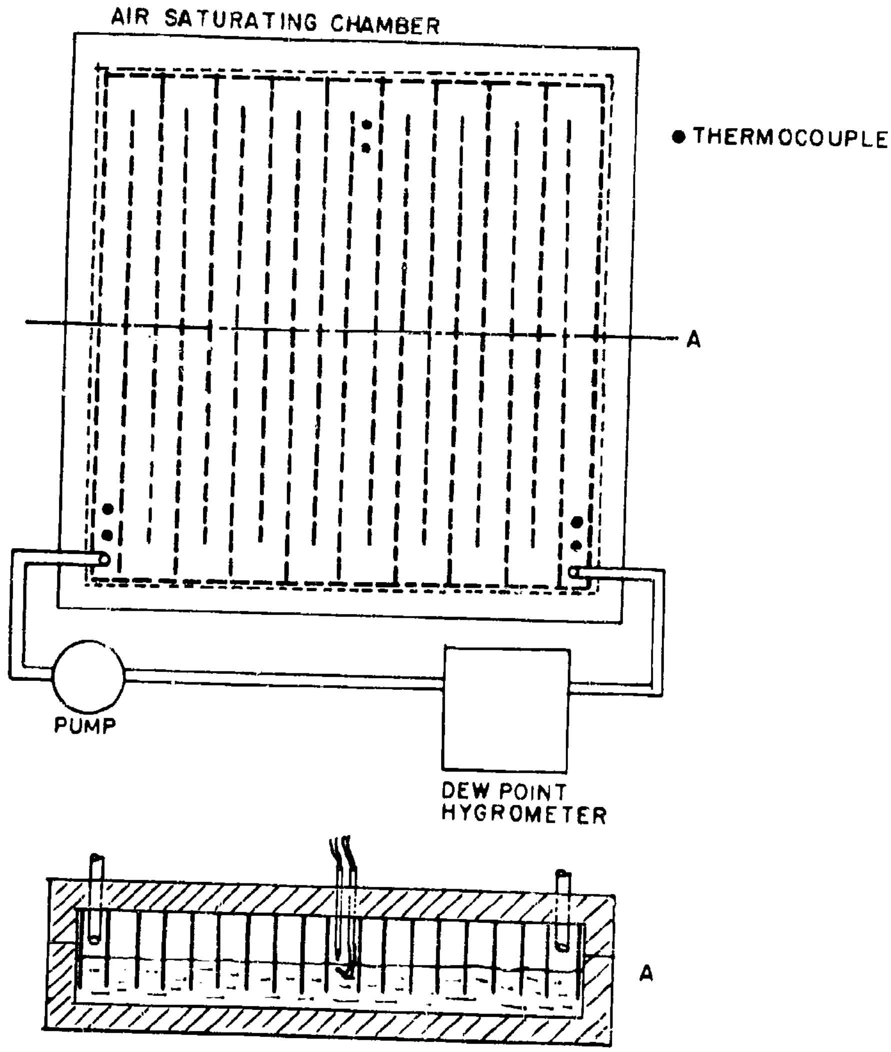


Figure 7.27 Air saturating chamber

and separated by insulating material 1-inch thick. The box was constructed in two sections to permit access to the chamber. The bottom section formed a pan 18 inches by 18 inches by 1.5 inches deep. The top section contained a labyrinth of baffle plates. The pan formed by the top section was 1.5 inches deep and the baffle plates were 2 inches in width. The bottom section was filled with distilled water and the top section was positioned in such a way that the lower edges of the baffle plates were immersed to a depth of 0.5 inches. In this way an enclosed and baffled air space 1.5 inches high was formed over the water surface. Glass tubing inserted through the top section of the chamber provided intake and exhaust ports. Air entering the chamber was confined to a path formed by the baffle plates. Between the intake and exhaust ports, the air path length was 27 feet. The air temperature and water temperature were measured by means of copper-constantan thermocouple junctions at three stations along the air path: at the intake port, at the exhaust port, and at the midpoint of the air path. The dew-point hygrometer, a pump, and the chamber were connected in a closed circuit by means of polyethylene tubing. The pump circulated air through the chamber and dew-point hygrometer at a speed sufficiently high to produce turbulent flow in the saturating chamber. The difference between air and water temperature at each station was observed. A condition of temperature equilibrium between air and water was used as an indication of saturation. The temperature at which saturation occurred was then taken as the actual dew point of the air. The condensation temperature or dew point as indicated by the dew-point hygrometer when operating with various dew-film thicknesses was compared with the saturation temperature. By repeated tests a dew-film thickness was established which produced agreement of saturation temperature and dew point as indicated by the dew-point hygrometer. To prevent condensation from occurring in the connecting polyethylene tubes which were virtually at room temperature, saturation temperatures less than room temperature were used. This was accomplished by using

water in the chamber having a temperature a few degrees below that of the room.

The accuracy of the dew-point measurements is at best equal to the accuracy of the calibration of the temperature measuring system. In addition there are sampling errors, and small random errors introduced in setting the dew-film thickness. Sampling errors are difficult to evaluate but are suspected to exist when a smooth profile is not obtained. Excluding sampling errors, absolute measurements are probably accurate to 0.06°C and relative measurements are probably accurate to 0.03°C.

Malfunctioning of the dew-point hygrometer was readily recognized by observing the behavior of the dew-film thickness meter. The presence of water in the sampling tubes could be detected by the behavior of the instrument and by readings of dew point which were greater than ambient temperature. Water in the sampling tubes sometimes occurred as a result of rain, fog or an inversion under humid conditions. The sampling tubes were necessarily cleared of water before resuming measurements. During the observation periods, moisture measurements were made by means of a sling psychrometer. These measurements were used as a check for gross error in the dew-point system.

7.3.7 Wind Profiles. Wind profiles were measured by a set of matched three-cup anemometers. Nineteen Rikoken* anemometers were modified, compared, and grouped in sets of seven matched units.

When received from the manufacturer, the Rikoken anemometers were equipped with gear trains and contact systems for counting the

*Manufactured by the Sanoya Iron Works,
1064 Nakata-machi, Kanuma-shi
Tochigi-ken, Japan

turns of the cups. The modification consisted of replacing the gear train and contact system with a photoelectric counting system. The latter system utilized a cadmium sulfide photoconductive cell and a No. 51 light bulb. The light reflected to the photocell by the mirror was interrupted by a shutter blade connected to the shaft which was turned by the cup assembly. In this way the photocell was illuminated and shaded once for each revolution of the cup assembly. The photoelectric counting system had several advantages not afforded by the gear train and contact system: (a) Friction due to the gear train and contacts was eliminated by use of the photoelectric system. Since this was the major portion of the friction in the instrument, its elimination resulted in lower starting speed. Also, the magnitude of this portion of the friction was not the same in each anemometer so its absence tended to make the anemometer characteristics more nearly alike. (b) The resolution (counts per revolution or counts per meter of air passage) obtained by using a photoelectric system which counted each revolution of the anemometer cups was 6.9 times as large as that provided by the gear train and contact system. Since the anemometer output was in digital or pulse form and was recorded by means of a digital counter (step function integrator), wind measurements having a resolution commensurate with accuracy could be obtained for a shorter time interval using the photoelectric system than by using the gear train and contact system. (c) Gear train and contact systems often produce spurious counts caused by contact bounce and intermittent conduction at the instant of make or break. The photoelectric system produced no spurious counts. (d) Contacts become pitted with use requiring that they be burnished or replaced. The photoelectric system required little and infrequent maintenance.

A unit having 8 counting channels (one for each anemometer and one spare) was used to register the number of revolutions of the anemometers. The circuit of a counting channel is shown in Figure 7.28. The circuit consists of a pulse-shaping stage, three bi-stable multivi-

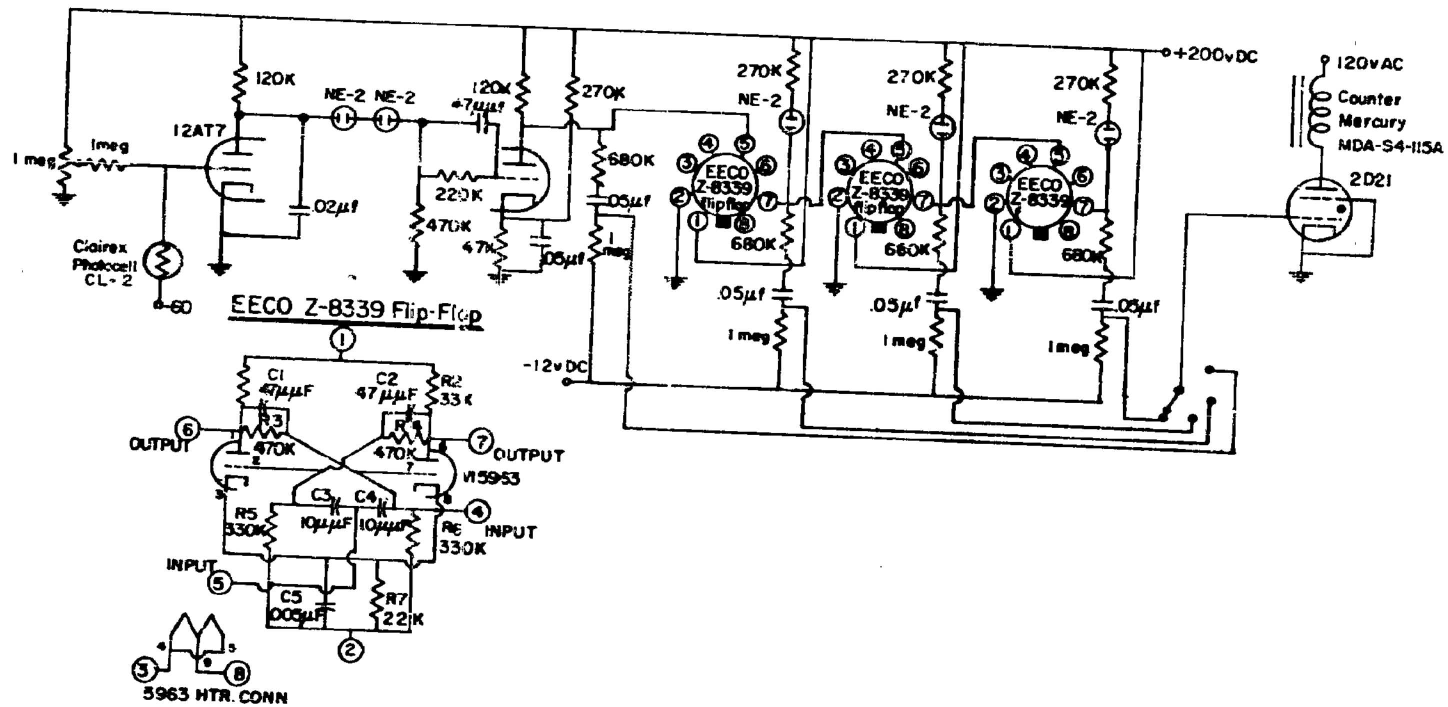


Figure 7.28 Counting circuit

brators, and a thyratron-driven electromechanical counter. Input pulses from the anemometer were converted to short rise time rectangular pulses. The output of the pulse-shaping stage was then fed to the three bistable multivibrators which were connected as a binary frequency divider. By means of a selector switch, the thyratron driven electromechanical counter could be connected to the output of the pulse-shaping stage or the output of any multivibrator. In this way the electromechanical counter was caused to register either each, every other, every fourth, or every eighth revolution of the anemometer. The electromechanical counter (mercury four-digit reset type) was rated at 10 counts per second. Since the anemometer speed could exceed this rate, the binary frequency divider was employed. In addition to enabling the counting circuit to accommodate a maximum input rate of 80 counts per second, the binary frequency divider reduced wear of the electromechanical counter when wind measurements were made which did not require the maximum available resolution.

The counting unit was constructed in three assemblies. The electronic portion of the counting channels was built on a single chassis. The threshold controls and count-down (frequency division) selector switches were located on this chassis. Two banks of electromechanical counters, a counter start-stop switch and a bank selector switch were mounted on a panel. One bank of counters could be read and reset while the other was registering counts. In this way successive profile measurements could be made without loss of data during the reading and reset periods. The power supply for the system was contained on a single chassis.

Prior to Project Prairie Grass, the anemometers were matched by means of a whirling device having four horizontal arms each eight feet long.[7] The anemometers were matched at O'Neill by mounting them at the same level on a horizontal support approximately two meters above the ground in an open field as far as possible from obstructions.[1] The support could accommodate 10 anemometers

having a horizontal spacing of approximately 1 foot.

An anemometer which was representative of the matched set was selected as a standard and its calibration was determined. This anemometer was calibrated in a wind tunnel* against a pitot tube which had been calibrated by the Bureau of Standards. Several trial calibrations were run to investigate the characteristics of the calibrating procedure and equipment. Four independent calibrations were then made and the average was taken as the true calibration. A check of this calibration was made using a different procedure and different calibrating apparatus.** The calibrating apparatus consisted of an airtight room (located in the laboratory building) having an air intake nozzle (9-inch throat diameter) in one wall and a volumetric flow rate-measuring exhaust nozzle in the opposite wall. By measuring the rate of flow out of the airtight room, the speed of the air entering the room through the intake nozzle could be determined. The anemometer was placed in the throat of the intake nozzle and its calibration determined. In the velocity range of 1 to 4.5 meters per second this calibration was virtually the same as the previous calibration. At higher velocities a difference was obtained. The calibrations differed by 2 percent at 5 meters per second and increased to 8 percent at 15 meters per second. A pitot tube was recognized to be most accurate at high velocities. The second calibrating technique was recognized to have an accuracy deficiency at high velocities. Both calibration techniques were unsatisfactory at velocities less than 1 meter per second since the air flow could not be maintained constant and the zero error and drift of the manometers became large compared to their readings. The calibration using the pitot tube, therefore, was accepted for the velocity

*Massachusetts Institute of Technology portable wind tunnel at O'Neill, Nebraska.

**This calibration was performed at the Fan Test Laboratory, Engineering Experiment Station, Texas A&M campus, October 1956.

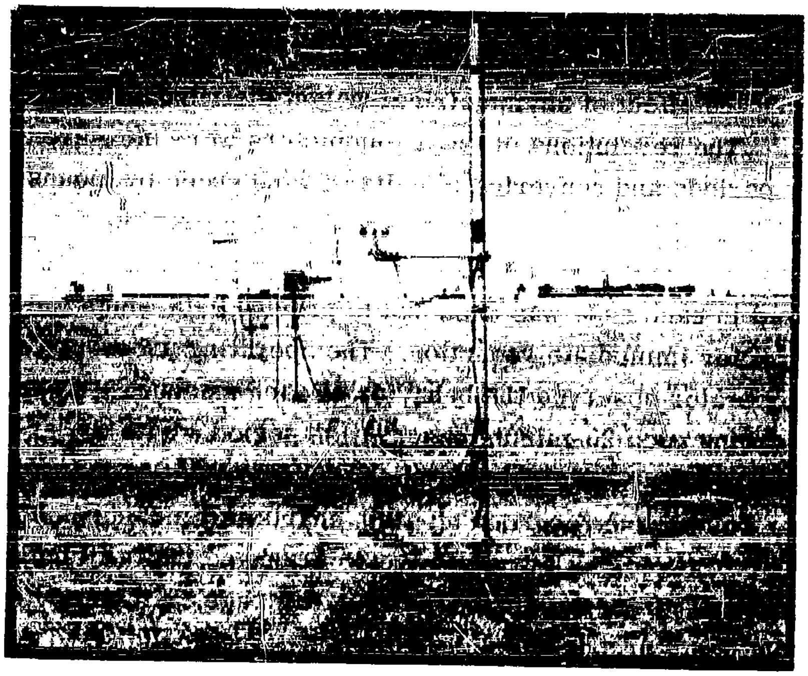


Figure 7.20 View of Rikoken anemometers installed at heights of 25, 50, and 100 cm

range of 1 to 15 meters per second. A third method was employed to obtain a calibration point at a velocity less than 1 meter per second. Under conditions of steady low velocity, virtually laminar flow at a height of 0.5 meters in the atmosphere* the wind velocity was measured by observing the time required for smoke from a cigarette to travel a measured distance, and the corresponding anemometer indication was obtained.

In measuring wind profiles, the anemometers were installed at the heights shown in Figure 7.3. The three lowest anemometers,

*These conditions existed at 2100 CST, 22 July 1956 at O'Neill.

those at 25, 50, and 100 cm, are shown in Figure 7.29. Each anemometer was carefully leveled so that the cups rotated in a horizontal plane thus minimizing the effect of asymmetrical weight distribution in the cup assembly.[1] The revolutions of the anemometers were measured for 20-minute periods and converted to units of wind speed by means of tables derived from the calibration curve shown in Figure 7.30.

7.3.8 Summary. In measuring these micrometeorological parameters, the method used in each case was designed to provide data which was in a convenient form for immediate reduction. The operating procedure was such that the operator observed the behavior of each measuring system at least once during each 20-minute observation period. With the exception of the radiation, wind direction and air temperature difference measurements which were recorded on strip charts, all measurements were recorded on data forms. These were so arranged that all tabulations and computations per data class were on one page. All computations were made from prepared tables, slide rule, and or standard desk calculator. This enabled the operator to reduce the data immediately after the measurements were made; hence, gross errors due to malfunctioning of the measuring equipment were noted and remedial action could be taken before measurements were resumed.

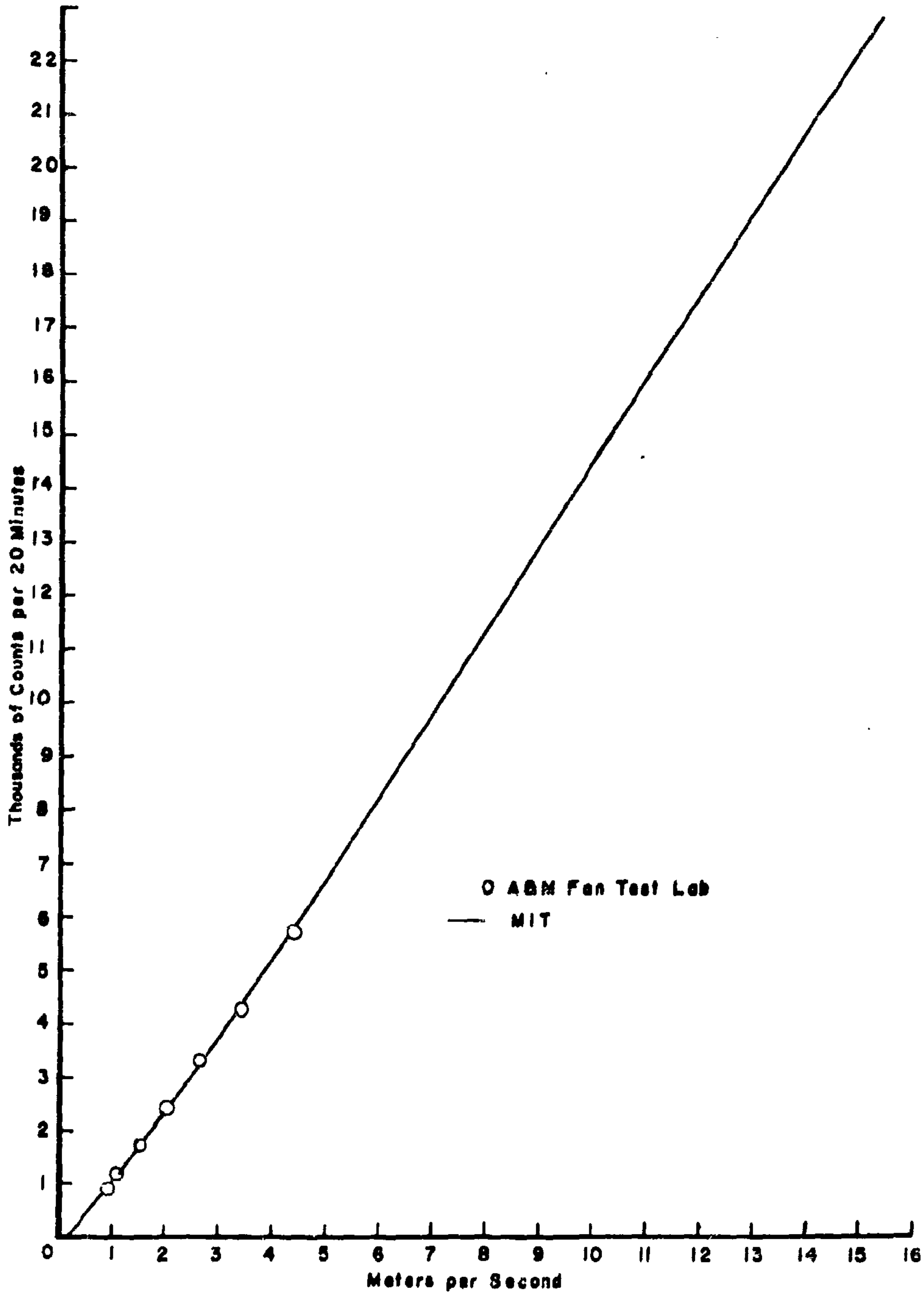


Figure 7.30 Anemometer calibration curve

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CHAPTER 8

MICROMETEOROLOGICAL DATA COLLECTED BY TEXAS A&M

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This section contains three groups of data collected during Project Prairie Grass. In the first group (Table 8.1) are micrometeorological data collected during the 68 regular and the two special gas releases. These observations covered a period of 20 minutes each, starting 5 minutes before and ending 5 minutes after the 10-minute period during which the gas was released.

The second group (Table 8.2) includes similar observations, but at times other than the 70 gas release times. 177 observational periods are included in this group.

The third group (Table 8.3) contains soil moisture and soil density data on four days during July and August.

*Present affiliation: U. S. Navy Electronics Laboratory

Table 8.1

HOURLY OBSERVATIONS						O'NEILL, NEBRASKA
GAS RELEASE NO.	1	2	3	4	5	6
JULY (1956)	3	3	5	6	6	6
CST	1105	1505	2205	0105	1405	1705
RADIATION (cal/cm²sec)						
Insolation	.0080	.0048	--	--	.0205	.0120
Reflected	--	--	--	--	--	--
Net Radiation	.0050	.0029	-.0013	-.0010	.0145	.0060
AIR and SOIL TEMPERATURES (°C)						
Height (m)						
16.00	--	--	--	--	--	--
8.00	21.68	23.78	22.41	20.09	29.18	30.19
4.00	21.90	23.79	21.12	18.55	29.72	30.50
2.00	22.12	23.87	19.83	17.50	30.17	30.80
1.00	22.32	23.99	18.45	16.75	30.71	31.09
.50	22.95	24.18	17.24	16.00	31.44	31.32
.25	23.22	24.54	16.89	15.63	32.05	31.63
.12	23.84	24.85	16.55	15.33	--	31.82
-.03	24.06	25.30	--	--	--	--
-.06	23.11	24.63	--	--	--	--
-.12	21.71	23.20	--	--	--	--
-.25	21.61	21.58	--	--	--	--
-.50	20.53	20.38	--	--	--	--
-1.00	18.21	18.18	--	--	--	--
VAPOR PRESSURE (mb)						
16.00	--	--	--	--	--	--
8.00	18.44	18.62	18.34	16.43	17.19	16.53
4.00	18.73	18.73	18.44	16.52	17.39	16.64
2.00	18.86	18.88	18.46	16.53	17.73	16.88
1.00	19.04	19.10	18.58	16.58	18.11	17.07
.50	19.51	19.38	18.58	16.64	18.46	17.24
.25	--	19.77	18.49	16.65	18.73	17.30
.12	19.95	20.21	18.96	17.29	19.27	17.41
WIND SPEED (cm/sec)						
16.00	--	--	--	--	--	--
8.00	321	233	211	304	703	846
4.00	289	216	113	202	651	765
2.00	258	190	44	120	593	680
1.00	239	174	66	91	515	599
.50	206	154	39	52	448	523
.25	173	122	16	17	378	439
WIND DIRECTION (deg)						
1.00	150	100	150	200	160	180
SOIL TEMPERATURE CHANGE (°C)						
Initial Time	--	1450	--	--	--	--
Run Time (min)	--	29	--	--	--	--
-.03	--	-.10	--	--	--	--
-.06	--	00	--	--	--	--
-.12	--	.11	--	--	--	--
-.25	--	.03	--	--	--	--
-.50	--	-.02	--	--	--	--
-1.00	--	-.01	--	--	--	--
Precipitation (cm)	--	--	--	--	--	--

Table 8.1 (Continued)

HOURLY OBSERVATIONS							O'NEILL, NEBRASKA
GAS RELEASE NO.	7	8	9	10	11	12	
JULY (1956)	10	10	11	11	14	14	
CST	1405	1705	1005	1205	0805	1005	
RADIATION (cal/cm²sec)							
Insolation	.0212	.0115	.0180	.0200	.0105	.0185	
Reflected	.0039	.0023	.0035	.0040	--	--	
Net Radiation	.0128	.0057	.0114	.0128	.0060	.0117	
AIR and SOIL TEMPERATURES (°C)							
Height (m)							
16.00	28.71	29.90	25.76	28.42	--	--	
8.00	29.04	30.15	26.25	28.98	24.16	28.83	
4.00	29.46	30.57	26.61	29.58	24.64	29.25	
2.00	30.27	31.10	27.39	30.45	25.01	29.67	
1.00	31.21	31.47	28.19	31.47	25.42	30.53	
.50	31.99	32.01	28.75	32.11	25.92	31.18	
.25	33.10	32.58	29.53	33.14	26.34	31.94	
.12	34.23	33.06	29.82	33.78	26.68	32.65	
-.03	34.90	33.74	26.64	31.79	24.23	28.86	
-.06	30.53	31.77	24.48	27.91	23.46	25.98	
-.12	24.23	26.77	23.14	23.93	24.25	24.16	
-.25	21.11	21.84	22.47	22.27	24.14	23.65	
-.50	20.03	19.99	20.42	20.34	21.49	21.34	
-1.00	18.22	18.22	18.28	18.20	18.75	18.68	
VAPOR PRESSURE (mb)							
16.00	12.06	13.16	20.60	22.84	--	--	
8.00	12.97	13.87	20.88	23.10	--	--	
4.00	13.02	13.72	20.92	23.14	--	--	
2.00	13.05	13.75	21.10	23.27	--	--	
1.00	13.18	13.85	21.14	23.40	--	--	
.50	13.50	13.98	21.20	23.43	--	--	
.25	13.85	14.16	21.39	23.59	--	--	
.12	14.15	14.32	21.92	23.62	--	--	
WIND SPEED (cm/sec)							
16.00	560	611	884	579	--	--	
8.00	508	540	842	536	944	973	
4.00	481	498	769	506	850	892	
2.00	444	452	700	468	761	799	
1.00	402	406	611	415	677	721	
.50	352	350	533	376	579	617	
.25	295	288	450	312	490	522	
WIND DIRECTION (deg)							
1.00	204	171	199	200	185	175	
SOIL TEMPERATURE CHANGE (°C)							
Initial Time	1351	1651	0950	1150	0750	0950	
Run Time (min)	27	26	16	26	28	27	
-.03	-1.80	-.76	1.01	.79	.80	.23	
-.06	.53	-.29	.59	.70	-.16	.72	
-.12	.53	.20	.06	.23	-.08	.10	
-.25	.07	.13	-.08	-.03	-.11	-.08	
-.50	00	-.03	-.01	-.01	-.03	-.01	
-1.00	00	00	-.01	00	-.01	-.01	
Precipitation (cm)	--	--	--	--	--	--	

Table 8.1 (Continued)

HOURLY OBSERVATIONS							O'NEILL, NEBRASKA	
GAS RELEASE NO.	13	14	15	16	17	18		
JULY (1956)	22	22	23	23	23	23		
CST	2005	2205	0805	1005	2005	2205		
RADIATION (cal/cm^{2}sec)								
Insolation	.0001	.0000	.0101	.0183	.0001	.0000		
Reflected	--	--	--	--	--	--		
Net Radiation	-.0011	-.0010	.0050	.0100	-.0011	-.0014		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	22.34	21.04	20.32	24.61	27.91	25.11		
8.00	21.64	19.76	20.51	24.82	27.83	24.30		
4.00	21.04	17.87	20.78	25.10	27.62	23.83		
2.00	20.39	16.25	21.44	25.61	27.44	23.52		
1.00	19.56	15.31	22.05	26.67	27.32	23.23		
.50	18.72	14.66	22.59	27.79	27.19	23.03		
.25	18.15	14.31	23.32	28.64	27.08	22.83		
.12	17.76	13.99	23.95	29.63	27.00	22.66		
-.03	26.48	23.10	20.75	26.71	29.49	26.39		
-.06	27.02	24.62	20.48	23.55	29.53	27.08		
-.12	25.50	24.95	21.44	21.62	27.26	26.51		
-.25	22.17	22.60	22.12	21.79	22.96	23.20		
-.50	20.36	20.48	20.72	20.68	20.32	20.28		
-1.00	18.95	19.02	19.04	18.99	18.54	18.62		
VAPOR PRESSURE (mb)								
16.00	16.13	14.91	17.19	17.66	--	--		
8.00	16.47	14.20	17.39	18.14	--	--		
4.00	16.74	14.21	17.41	18.21	--	--		
2.00	16.60	14.20	17.43	18.30	--	--		
1.00	16.02	14.25	17.52	18.40	--	--		
.50	15.86	14.27	17.63	18.57	--	--		
.25	15.71	14.32	17.65	18.81	--	--		
.12	15.71	14.99	17.77	19.08	--	--		
WIND SPEED (cm/sec)								
16.00	343	445	--	378	555	656		
8.00	264	348	378	362	455	488		
4.00	198	225	354	346	402	375		
2.00	146	139	322	331	341	322		
1.00	92	74	290	296	287	268		
.50	46	41	261	265	237	229		
.25	18	16	215	225	209	186		
WIND DIRECTION (deg)								
1.00	--	--	193	202	172	188		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	1952	2150	0752	0950	1050	2155		
Run Time (min)	25	30	24	27	26	22		
-.03	-1.08	-.68	.79	1.54	-.76	-.83		
-.06	-.63	-.60	.32	.92	-.59	-.70		
-.12	-.07	-.18	-.04	.17	-.10	-.25		
-.25	.04	.04	-.04	-.02	.05	-.07		
-.50	-.05	.04	00	.01	00	-.04		
-1.00	-.04	.02	00	-.02	00	-.01		
Precipitation (cm)	--	--	--	--	--	--		

Table 8.1 (Continued)

HOURLY OBSERVATIONS						O'NEILL, NEBRASKA
GAS RELEASE NO.	19	20	21	22	23	24
JULY (1956)	25	25	25	26	29	29
CST	1105	1305	2205	0005	2105	2305
RADIATION (cal/cm²sec)						
Insolation	.0140	.0218	--	--	--	--
Reflected	.00290	.00415	--	--	--	--
Net Radiation	.0081	.0137	-.0009	-.0014	-.0014	-.00115
AIR and SOIL TEMPERATURES (°C)						
Height (m)						
16.00	27.26	30.14	28.91	26.75	23.62	22.07
8.00	27.77	30.88	28.84	26.70	23.52	21.99
4.00	28.04	31.87	28.74	26.60	23.49	21.96
2.00	28.59	32.49	28.60	26.42	23.40	21.89
1.00	29.28	33.34	28.50	26.32	23.31	21.83
.50	29.75	34.31	28.42	26.22	23.21	21.74
.25	30.56	35.16	28.32	26.05	23.11	21.71
.12	31.06	35.98	28.19	25.93	23.04	21.63
-.03	28.52	33.60	27.70	26.32	27.92	25.85
-.06	24.91	28.89	27.65	26.57	28.14	26.38
-.12	22.80	23.92	26.76	26.11	26.83	26.16
-.25	22.74	22.56	23.90	24.06	23.98	24.10
-.50	21.21	21.12	21.14	21.17	21.63	21.65
-1.00	19.00	18.94	19.04	19.08	19.62	19.62
VAPOR PRESSURE (mb)						
16.00	14.91	14.19	14.56	15.81	--	--
8.00	15.22	14.33	14.65	15.87	--	--
4.00	15.24	14.39	14.66	15.81	--	--
2.00	15.30	14.41	14.60	15.82	--	--
1.00	15.41	14.47	14.62	15.80	20.7*	20.9*
.50	15.60	14.51	14.64	15.81	--	--
.25	15.60	14.57	14.65	15.77	--	--
.12	15.73	14.71	14.59	15.75	--	--
WIND SPEED (cm/sec)						
16.00	752	1211	850	1041	883	865
8.00	721	1130	772	933	784	764
4.00	627	1017	675	814	685	662
2.00	--	938	611	739	605	586
1.00	533	826	531	639	537	521
.50	475	727	462	557	471	461
.25	393	594	376	454	389	382
WIND DIRECTION (deg)						
1.00	162	168	167	170	132	146
SOIL TEMPERATURE CHANGE (°C)						
Initial Time	1050	1250	2154	2350	2050	2250
Run Time (min)	26	27	23	26	26	27
-.03	.91	.67	-.16	-.24	-.53	-.78
-.06	.96	.64	-.20	-.11	-.43	-.77
-.12	.13	.37	-.21	-.11	-.12	-.33
-.25	-.04	-.01	.02	.05	.06	-.12
-.50	-.02	-.01	-.01	00	00	00
-1.00	-.01	00	-.01	.01	00	-.03
Precipitation (cm)	--	--	--	--	--	--

* Sling Psychrometer

Table 8.1 (Continued)

HOURLY OBSERVATIONS						O'NEILL, NEBRASKA
GAS RELEASE NO.	25	26	27	28	29	30
AUGUST (1956)	1	2	2	3	3	3
CST	1305	1205	1405	0005	0205	1305
RADIATION (cal/cm²sec)						
Insolation	.0092	.0180	.0183	--	--	.0202
Reflected	.00185	.00305	--	--	--	.00329
Net Radiation	.0052	.0126	.0123	--	-.0003	.0129
AIR and SOIL TEMPERATURES (°C)						
Height (m)						
16.00	22.87	--	--	25.24	26.24	31.88
8.00	22.92	27.93	30.26	24.76	25.81	32.39
4.00	23.26	28.57	30.84	24.38	25.72	32.96
2.00	23.62	29.21	31.43	24.22	25.30	33.63
1.00	24.09	29.91	31.96	24.07	25.14	34.00
.50	24.77	30.42	32.62	23.92	24.78	34.73
.25	25.32	31.15	33.46	23.72	24.58	35.42
.12	25.72	31.74	34.25	23.53	24.33	36.10
-.03	27.41	27.41	29.97	23.68	22.92	33.29
-.06	25.32	25.42	27.84	24.64	23.78	30.50
-.12	22.91	22.96	23.93	25.25	24.60	25.03
-.25	22.50	22.34	22.31	23.74	23.68	22.94
-.50	21.73	21.38	21.31	21.58	21.52	21.58
-1.00	19.82	19.70	19.65	19.82	19.82	19.71
VAPOR PRESSURE (mb)						
16.00	--	--	--	--	--	18.67
8.00	22.57	22.43	21.72	--	--	19.27
4.00	22.40	22.69	21.86	--	--	19.48
2.00	22.63	23.02	22.02	--	--	19.74
1.00	--	23.40	22.29	--	--	20.07
.50	--	23.72	22.44	--	--	20.53
.25	23.28	23.92	22.57	--	--	20.65
.12	23.75	24.31	22.82	--	--	21.04
WIND SPEED (cm/sec)						
16.00	328	851	849	508	606	885
8.00	318	775	755	388	529	852
4.00	297	721	694	321	441	775
2.00	275	648	613	255	394	697
1.00	248	568	540	212	340	628
.50	221	511	483	177	296	540
.25	173	422	402	154	241	455
WIND DIRECTION (deg)						
1.00	183	171	170	167	208	196
SOIL TEMPERATURE CHANGE (°C)						
Initial Time	1252	1150	1350	2357	0150	1250
Run Time (min)	26	27	26	20	27	26
-.03	.04	1.35	1.10	-.51	-.21	.72
-.06	.21	1.09	.69	-.61	-.17	.74
-.12	.07	.14	.36	-.45	-.10	.02
-.25	-.04	-.06	.11	-.27	-.01	.05
-.50	-.03	-.07	.05	-.20	.02	00
-1.00	-.03	-.04	.06	-.31	00	.02
Precipitation (cm)	--	--	--	--	--	--

Table 8.1 (Continued)

HOURLY OBSERVATIONS							O'NEILL, NEBRASKA
GAS RELEASE NO.	31	32	33	34	35a	35	36
AUGUST (1956)	3	6	7	7	7	11	11
CST	1505	2005	1305	1505	2305	2135	2335
RADIATION (cal/cm²sec)							
Insolation	.0152	.0000	.0164	.0174	--	--	--
Reflected	.00264	--	--	--	--	--	--
Net Radiation	.0092	-.0013	.0109	.0113	-.0007	-.00091	-.00085
AIR and SOIL TEMPERATURES (°C)							
Height (m)							
16.00	33.23	27.21	21.71	29.09	23.03	23.57	20.74
8.00	33.44	25.33	27.88	29.21	22.68	22.30	19.81
4.00	33.79	23.71	28.16	29.68	22.47	21.04	19.32
2.00	34.25	22.93	28.73	30.19	22.28	19.73	18.94
1.00	34.85	22.45	29.16	30.99	22.17	19.13	18.63
.50	35.37	22.06	29.64	31.45	22.05	18.47	18.10
.25	35.81	21.66	30.07	32.13	21.94	18.34	18.19
.12	36.11	21.38	30.61	32.62	21.79	18.21	17.98
-.03	34.04	25.35	29.57	31.07	23.42	24.85	23.15
-.06	32.10	26.42	27.07	28.96	24.41	26.02	24.41
-.12	26.80	26.18	23.43	24.86	25.22	26.27	25.49
-.25	23.11	24.00	22.58	22.73	23.93	23.78	24.01
-.50	21.50	22.02	21.80	21.82	21.91	21.63	21.74
-1.00	19.69	19.94	19.89	19.93	20.08	19.99	20.08
VAPOR PRESSURE (mb)							
16.00	18.49	13.82	16.64	17.00	19.99	19.08	18.30
8.00	18.65	14.39	16.97	17.21	20.12	18.93	18.43
4.00	18.76	15.08	17.16	17.38	20.17	19.06	18.44
2.00	18.79	15.54	17.41	17.51	20.17	18.91	18.44
1.00	19.07	15.85	17.62	17.76	20.23	18.84	18.52
.50	19.20	16.01	17.77	17.97	20.27	19.32	18.83
.25	19.34	16.09	18.09	18.10	20.27	18.59	18.59
.12	19.33	16.12	18.36	18.26	20.33	18.59	18.83
WIND SPEED (cm/sec)							
16.00	1013	609	1063	1214	639	421	464
8.00	--	412	--	1128	520	318	342
4.00	887	288	848	1052	434	253	243
2.00	787	213	756	920	373	180	186
1.00	691	160	690	846	340	110	137
.50	617	136	580	706	281	88	116
.25	527	95	484	587	231	45	81
WIND DIRECTION (deg)							
1.00	204	168	171	140	164	97	154
SOIL TEMPERATURE CHANGE (°C)							
Initial Time	1450	1950	1250	1450	2255	2120	2320
Run Time (min)	28	27	27	28	21	26	30
-.03	-.06	-.70	.10	.14	-.38	-.47	-.35
-.06	.25	-.55	.64	.31	-.39	-.42	-.38
-.12	.25	-.09	.22	.25	-.19	-.12	-.23
-.25	.10	.05	-.12	.02	-.04	.12	00
-.50	00	.01	-.11	-.04	.05	.04	.01
-1.00	00	.01	-.08	-.03	-.04	.04	00
Precipitation (cm)	--	--	--	--	--	--	--

Table 8.1 (Continued)

HOURLY OBSERVATIONS						O'NEILL, NEBRASKA
GAS RELEASE NO.	37	38	39	40	41	42
AUGUST (1956)	12	12	13	14	14	14
CST	0305	0505	2235	0035	0305	0505
RADIATION (cal/cm²sec)						
Insolation	--	--	--	--	--	--
Reflected	--	--	--	--	--	--
Net Radiation	-.00087	-.00085	-.00135	-.0014	-.00123	-.00192
AIR and SOIL TEMPERATURES (°C)						
Height (m)						
16.00	21.02	20.07	23.68	21.91	21.63	21.92
8.00	20.90	19.93	22.39	21.11	20.82	21.68
4.00	20.79	19.84	21.28	20.69	20.43	21.61
2.00	20.65	19.82	20.47	20.29	20.20	21.49
1.00	20.55	19.65	20.01	19.96	20.03	21.30
.50	20.41	19.34	19.55	19.52	19.90	21.16
.25	20.33	19.48	19.35	19.29	19.62	21.03
.12	20.22	19.37	19.06	19.08	19.43	20.90
-.03	21.68	21.59	25.09	23.64	22.26	21.92
-.06	22.69	22.37	26.52	24.88	23.53	22.82
-.12	24.21	23.62	27.42	26.41	25.28	24.56
-.25	23.83	23.62	24.63	24.89	24.80	24.47
-.50	21.80	21.81	21.87	21.92	22.06	22.06
-1.00	20.08	20.05	20.03	20.02	20.09	22.03
VAPOR PRESSURE (mb)						
16.00	19.61	19.77	12.82	13.11	14.93	14.13
8.00	19.62	19.77	12.91	13.15	15.03	14.14
4.00	19.63	19.82	12.92	13.18	15.09	14.19
2.00	19.62	19.75	12.92	13.19	15.07	14.16
1.00	19.63	19.73	12.94	13.21	15.08	14.20
.50	20.11	20.00	12.95	13.22	15.08	14.23
.25	19.68	19.72	12.93	13.23	15.09	14.22
.12	19.84	19.73	12.99	13.31	15.09	14.23
WIND SPEED (cm/sec)						
16.00	726	679	542	486	671	828
8.00	608	585	419	343	550	751
4.00	528	504	291	250	435	673
2.00	459	428	229	208	369	594
1.00	400	370	169	158	316	527
.50	344	317	152	137	267	452
.25	281	258	112	99	216	380
WIND DIRECTION (deg)						
1.00	176	161	122	166	185	199
SOIL TEMPERATURE CHANGE (°C)						
Initial Time	0250	0450	2220	0020	0250	0450
Run Time (min)	30	26	28	28	28	28
-.03	.06	-.12	-.46	-.27	-.10	-.05
-.06	-.13	-.09	-.45	-.30	-.18	.01
-.12	-.29	-.11	-.25	-.25	-.15	-.14
-.25	-.04	-.06	.02	-.04	-.03	-.06
-.50	00	-.01	00	.01	.01	.01
-1.00	-.01	-.01	-.02	00	.02	00
Precipitation (cm)	--	--	--	--	--	--

Table 8.1 (Continued)

HOURLY OBSERVATIONS								O'NEILL, NEBRASKA
GAS RELEASE NO.	43	44	45	46	47	48s	48s	48
AUGUST (1956)	15	15	15	15	20	20	20	21
CST	1205	1405	1705	1850	1005	1205	1255	0905
RADIATION (cal/cm²sec)								
Insolation	.0178	.0104	.00443	.00035	.0187	.0125	--	.0142
Reflected	.0030	.0028	.00080	--	.00313	.00215	--	.00253
Net Radiation	.0108	.0097	.0014	-.0014	.0108	.0070	--	.0081
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	31.63	33.92	34.59	33.12	16.81	18.55	19.29	17.18
8.00	32.09	34.37	34.75	33.01	17.10	18.77	19.71	17.70
4.00	32.60	34.73	34.91	32.90	17.47	19.04	20.11	18.05
2.00	33.05	35.43	35.04	32.74	17.73	19.45	20.72	18.40
1.00	34.17	36.06	35.28	32.57	18.46	19.91	21.31	18.96
.50	34.92	36.92	35.59	32.44	19.20	20.52	22.10	19.43
.25	35.76	37.69	35.82	32.32	20.13	21.12	23.15	19.97
.12	36.64	38.64	35.95	32.20	21.30	22.02	24.44	20.46
-.03	33.60	37.31	35.56	32.59	18.27	25.66	--	17.12
-.06	28.82	32.25	33.03	31.07	17.79	22.57	--	16.89
-.12	24.63	26.11	27.99	28.32	18.21	19.07	--	18.40
-.25	23.75	23.72	24.11	24.49	20.24	19.87	--	20.52
-.50	22.29	22.25	22.12	22.09	20.96	20.78	--	20.73
-1.00	20.13	20.11	20.08	20.05	20.28	20.13	--	20.04
VAPOR PRESSURE (mb)								
16.00	11.83	10.64	11.90	11.41	--	9.73	--	12.53
8.00	12.28	11.17	12.17	11.51	--	10.09	--	12.78
4.00	12.36	11.16	12.18	11.57	--	10.26	--	12.81
2.00	12.46	11.15	12.21	11.63	--	10.35	--	12.93
1.00	12.50	11.19	12.20	11.64	--	10.49	--	13.03
.50	12.61	11.30	12.31	11.64	--	10.58	--	13.17
.25	12.74	11.33	12.39	11.68	--	10.86	--	13.27
.12	12.95	11.41	12.34	11.70	--	11.33	--	13.38
WIND SPEED (cm/sec)								
16.00	641	760	788	787	394	356	376	1027
8.00	606	719	735	707	374	347	365	961
4.00	565	680	665	625	356	329	342	--
2.00	522	--	602	556	332	307	3.21	784
1.00	468	539	531	486	302	277	2.94	691
.50	411	468	460	428	270	249	2.96	606
.25	343	307	378	364	--	210	2.23	505
WIND DIRECTION (deg)								
1.00	168	156	153	134	--	216	--	189
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	1150	1350	1650	1835	0950	1150	--	0850
Run Time (min)	27	28	26	27	26	28	--	27
-.03	.67	.21	-.57	-.77	1.87	.47	--	.90
-.06	.60	.52	-.25	-.40	.70	1.03	--	.52
-.12	.22	.36	.13	-.05	.03	.34	--	00
-.25	-.09	.03	.08	.05	.03	-.06	--	-.08
-.50	-.03	-.02	-.02	-.04	-.04	-.03	--	-.02
-1.00	-.02	-.01	00	-.07	-.04	-.01	--	-.02
Precipitation (cm)	--	--	--	--	--	--	--	--

Table 8.1 (Continued)

HOURLY OBSERVATIONS						O'NEILL, NEBRASKA
GAS RELEASE NO.	55	56	57	58	59	60
AUGUST (1956)	25	25	25	25	25	26
CST	0105	0305	1735	1935	2235	0035
RADIATION (cal/cm²sec)						
Insolation	--	--	.0054	--	--	--
Reflected	--	--	.00087	--	--	--
Net Radiation	-.0015	-.0014	.0013	-.0013	-.0014	-.0014
AIR and SOIL TEMPERATURES (°C)						
Height (m)						
16.00	17.17	15.88	33.54	29.50	26.61	26.49
8.00	17.08	15.70	33.76	28.49	25.34	26.17
4.00	16.90	15.47	33.91	27.16	24.31	25.91
2.00	16.75	15.29	34.11	23.64	23.60	25.75
1.00	16.65	15.15	34.19	25.64	23.13	25.49
.50	16.48	15.03	34.33	25.13	22.82	25.35
.25	16.37	14.91	34.52	24.82	22.58	25.14
.12	16.20	14.77	34.61	24.58	22.29	24.98
-.03	20.56	19.42	31.70	28.09	24.52	23.28
-.06	21.43	20.85	29.54	27.97	25.12	23.87
-.12	23.58	22.75	25.51	25.90	25.10	24.46
-.25	23.04	22.62	22.19	22.49	22.99	23.09
-.50	21.02	21.02	20.89	20.78	20.89	20.94
-1.00	19.71	19.68	19.46	19.51	19.59	19.60
VAPOR PRESSURE (mb)						
16.00	11.72	12.37	12.39	--	12.82	11.89
8.00	11.73	12.21	12.50	--	12.99	11.96
4.00	11.73	12.29	12.55	--	13.05	11.97
2.00	11.73	12.39	12.56	--	13.11	11.97
1.00	11.74	12.39	12.59	--	13.10	12.01
.50	11.73	12.36	12.61	--	13.14	12.04
.25	11.73	12.36	12.63	--	13.15	12.06
.12	11.72	12.30	12.65	--	13.15	12.08
WIND SPEED (cm/sec)						
16.00	830	704	969	572	628	723
8.00	755	619	879	433	462	595
4.00	679	546	824	311	342	533
2.00	594	475	720	224	261	457
1.00	517	415	642	165	202	404
.50	446	361	556	131	168	349
.25	374	299	469	103	134	294
WIND DIRECTION (deg)						
1.00	143	138	185	158	160	182
SOIL TEMPERATURE CHANGE (°C)						
Initial Time	0050	0250	1722	1923	2227	0028
Run Time (min)	26	26	25	25	19	18
-.03	-.24	-.21	.07	-.86	-.39	-.10
-.06	-.21	.22	-.22	-.51	-.24	-.17
-.12	-.17	-.22	.16	-.03	-.13	-.13
-.25	-.01	-.04	.08	.11	.03	-.03
-.50	00	00	.01	.03	.01	00
-1.00	00	-.02	-.01	.02	.01	00
Precipitation (cm)		--	--	--	--	--

Table 8.1 (Continued)

HOURLY OBSERVATIONS						O'NEILL, NEBRASKA
GAS RELEASE NO.	49	50	51	52	53	54
AUGUST (1956)	21	21	21	24	24	24
CST	1105	1405	1535	1120	2005	2205
RADIATION (cal/cm²sec)						
Insolation	.0209	.0202	.0158	.0204	--	--
Reflected	.00303	.00309	.00259	.00289	--	--
Net Radiation	.0129	.0128	.0088	.0110	-.0015	-.0017
AIR and SOIL TEMPERATURES (°C)						
Height (m)						
16.00	21.45	27.14	28.36	23.17	21.32	19.56
8.00	21.94	27.68	29.13	23.59	20.26	19.31
4.00	22.64	27.90	29.40	24.08	18.77	18.94
2.00	23.20	28.04	29.80	24.96	17.39	18.68
1.00	24.05	29.20	30.50	25.98	16.56	18.45
.50	25.00	30.05	31.07	26.74	15.76	18.25
.25	25.72	31.23	31.97	27.95	15.37	18.04
.12	26.38	31.95	32.52	29.19	14.90	17.89
-.03	22.77	29.55	30.45	27.56	25.07	22.48
-.06	20.34	26.18	27.78	23.69	26.32	23.92
-.12	18.86	21.20	22.45	21.12	25.65	24.88
-.25	20.15	19.99	20.12	21.57	22.66	22.96
-.50	20.60	20.45	20.34	20.91	20.82	20.60
-1.00	19.92	19.83	19.73	19.58	19.56	19.64
VAPOR PRESSURE (mb)						
16.00	14.03	14.09	12.94	9.22	10.64	11.40
8.00	13.84	14.35	13.21	10.72	10.79	11.42
4.00	13.77	14.39	13.23	10.69	10.75	11.42
2.00	13.60	14.49	13.34	10.79	10.74	11.40
1.00	13.47	14.59	13.53	11.19	10.78	11.42
.50	13.29	14.68	13.57	11.10	10.86	11.41
.25	13.20	14.75	13.66	11.21	10.84	11.39
.12	12.87	14.93	13.92	11.49	10.84	11.42
WIND SPEED (cm/sec)						
16.00	808	819	869	521	594	641
8.00	802	796	804	508	446	537
4.00	752	764	766	496	320	464
2.00	674	673	682	442	228	394
1.00	603	606	618	404	156	340
.50	522	--	547	--	137	299
.25	444	448	475	308	101	248
WIND DIRECTION (deg)						
1.00	185	197	226	--	119	147
SOIL TEMPERATURE CHANGE (°C)						
Initial Time	1059	1350	1520	1150	1950	2150
Run Time (min)	28	28	25	26	26	27
-.03	1.44	.56	-.02	1.21	-.90	-.35
-.06	.97	.60	.20	.89	-.61	-.44
-.12	.22	.40	.34	.20	-.12	-.21
-.25	-.06	.02	.04	.08	.07	.04
-.50	-.03	-.02	-.03	-.02	-.01	00
-1.00	-.01	-.03	-.02	-.02	.01	00
Precipitation (cm)	--	--	--	--	--	--

Table 8.1 (Continued)

HOURLY OBSERVATIONS						O'NEILL, NEBRASKA
GAS RELEASE NO.	61	62	63	64	65	66
AUGUST (1956)	27	27	27	27	29	29
CST	1105	1405	2005	2236	1930	2135
RADIATION (cal/cm²sec)						
Insolation	.0190	.0110	--	--	--	--
Reflected	.0030	.00174	--	--	--	--
Net Radiation	.0019	-.0072	-.0011	-.0005	-.0022	-.0018
AIR and SOIL TEMPERATURES (°C)						
Height (m)						
16.00	29.80	29.77	29.52	26.77	25.98	22.02
8.00	30.41	30.00	27.27	23.85	25.61	21.22
4.00	31.00	30.49	25.54	22.16	25.22	20.65
2.00	31.63	30.75	24.07	20.90	24.96	20.19
1.00	32.29	31.15	21.41	19.60	24.76	19.88
.50	33.20	31.58	19.24	18.70	24.57	19.57
.25	34.10	32.10	18.17	18.16	24.30	19.27
.12	34.61	32.35	17.57	17.83	24.04	18.99
-.03	30.12	30.02	26.64	23.49	--	--
-.06	25.86	28.56	27.33	24.68	--	--
-.12	23.60	25.44	26.30	25.54	--	--
-.25	23.19	23.01	23.77	23.98	--	--
-.50	21.49	21.39	21.55	21.59	--	--
-1.00	19.66	19.61	19.56	19.78	--	--
VAPOR PRESSURE (mb)						
16.00	11.64	12.41	15.09	15.33	--	--
8.00	12.15	12.56	15.04	15.68	--	--
4.00	12.10	12.67	14.68	15.87	--	--
2.00	12.20	12.83	14.13	15.58	--	--
1.00	12.20	12.91	13.64	15.16	--	--
.50	12.28	13.13	13.20	14.86	--	--
.25	12.36	13.30	12.75	14.69	--	--
.12	12.44	13.47	12.20	14.51	--	--
WIND SPEED (cm/sec)						
16.00	980	632	207	307	768	650
8.00	926	603	195	209	626	506
4.00	--	583	139	169	530	392
2.00	782	518	116	120	455	314
1.00	700	461	26	46	393	256
.50	614	405	--	25	339	217
.25	520	343	--	--	277	177
WIND DIRECTION (deg)						
1.00	190	189	--	--	159	153
SOIL TEMPERATURE CHANGE (°C)						
Initial Time	1050	1353	1950	2220	--	--
Run Time (min)	28	23	27	27	--	--
-.03	1.40	.46	-.80	-.24	--	--
-.06	.82	-.27	-.54	-.31	--	--
-.12	.11	.15	-.03	-.19	--	--
-.25	-.08	.03	.08	.01	--	--
-.50	-.05	.01	.04	00	--	--
-1.00	-.03	00	.05	00	--	--
Precipitation (cm)	--	--	--	--	--	--

Table 8.1 (Continued)

HOURLY OBSERVATIONS								O'NEILL, NEBRASKA
GAS RELEASE NO.	67	68						
AUGUST (1956)	30	30						
CST	0035	0235						
RADIATION (cal/cm²sec)								
Insolation	--	--						
Reflected	--	--						
Net Radiation	-.0011	-.0009						
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	21.12	21.97						
8.00	20.88	21.36						
4.00	20.66	20.94						
2.00	20.55	20.65						
1.00	20.38	20.38						
.50	20.21	20.24						
.25	20.19	20.08						
.12	20.02	19.88						
-.03	--	--						
-.06	--	--						
-.12	--	--						
-.25	--	--						
-.50	--	--						
-1.00	--	--						
VAPOR PRESSURE (mb)								
16.00	--	--						
8.00	--	--						
4.00	--	--						
2.00	--	--						
1.00	--	--						
.50	--	--						
.25	--	--						
.12	--	--						
WIND SPEED (cm/sec)								
16.00	748	558						
8.00	615	427						
4.00	521	331						
2.00	444	269						
1.00	385	219						
.50	336	188						
.25	274	149						
WIND DIRECTION (deg)								
1.00	168	159						
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	--	--						
Run Time (min)	--	--						
-.03	--	--						
-.06	--	--						
-.12	--	--						
-.25	--	--						
-.50	--	--						
-1.00	--	--						

Precipitation (cm)	--	--

Table 8.2

HOURLY OBSERVATIONS		July 10, 1956			O'NEILL, NEBRASKA		
CST	1305	1405	1505	1605	1705	1805	
RADIATION (cal/cm²sec)							
Insolation	.0225	.0212	.0187	.0150	.0115	.0068	
Reflected	.0040	.0039	.0036	.0027	.0023	.0015	
Net Radiation	.0138	.0128	.0108	.0085	.0057	.0025	
AIR and SOIL TEMPERATURES (°C)							
Height (m)							
16.00	28.55	28.71	29.22	29.85	29.90	29.89	
8.00	29.09	29.04	29.57	30.18	30.15	30.12	
4.00	29.21	29.46	29.75	30.61	30.57	30.34	
2.00	29.84	30.27	30.34	30.73	31.10	30.52	
1.00	30.50	31.21	31.10	31.61	31.47	30.79	
.50	32.01	31.99	32.01	32.30	32.01	31.00	
.25	32.93	33.10	33.39	33.22	32.58	31.16	
.12	33.92	34.33	34.27	34.16	33.06	31.38	
-.03	33.68	34.89	35.41	35.22	33.74	31.75	
-.06	29.89	30.53	31.58	32.08	31.77	30.82	
-.12	23.25	24.23	25.34	26.16	26.77	27.19	
-.25	21.01	21.11	21.27	21.55	21.84	22.17	
-.50	20.07	20.03	19.97	20.00	19.99	19.97	
-1.00	18.23	18.22	18.19	18.22	18.22	18.20	
VAPOR PRESSURE (mb)							
16.00	11.90	12.06	12.12	13.28	13.16	13.41	
8.00	13.06	12.97	13.07	13.81	13.87	13.59	
4.00	13.03	13.02	13.10	13.87	13.72	13.63	
2.00	13.12	13.05	13.16	13.92	13.75	13.69	
1.00	13.32	13.18	13.42	14.15	13.85	13.78	
.50	13.71	13.50	13.63	14.52	13.98	13.88	
.25	14.26	13.85	13.94	14.65	14.16	13.93	
.12	14.81	14.15	14.31	15.12	14.32	14.02	
WIND SPEED (cm/sec)							
16.00	362	560	470	506	611	827	
8.00	314	508	433	461	540	710	
4.00	324	481	408	427	498	647	
2.00	298	444	379	390	452	572	
1.00	277	402	350	353	406	503	
.50	246	352	309	308	350	432	
.25	203	295	257	253	288	362	
WIND DIRECTION (deg)							
1.00	--	205	--	--	171	--	
SOIL TEMPERATURE CHANGE (°C)							
Initial Time	1253	--	1452	1550	1757	--	
Run Time (min)	26	--	29	20	21	--	
-.03	.65	--	.02	-.37	--	--	
-.06	.85	--	.40	.06	--		
-.12	.55	--	.39	.35	--	--	
-.25	.02	--	.08	.12	--	--	
-.50	-.05	--	-.04	-.01	--	--	
-1.00	0	--	-.01	0	--	--	
Precipitation (cm)	--	--	--	--	--	--	

Table 8.2 (Continued)

HOURLY OBSERVATIONS	July 10, 1956				O'NEILL, NEBRASKA			
CST	1905	2005	2105	0005*	0105*	0205*		
RADIATION (cal/cm^{2}sec)								
Insolation	.0002	--	--	--	--	--		
Reflected	.0004	--	--	--	--	--		
Net Radiation	-.0004	-.0017	-.0016	-.0014	-.0013	-.0013		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	29.15	26.90	25.72	--	--	--		
8.00	29.12	26.36	25.06	23.29	21.99	21.92		
4.00	29.07	25.90	24.47	23.03	21.61	21.50		
2.00	29.03	25.50	24.13	22.86	21.38	21.24		
1.00	28.99	25.26	23.81	22.63	21.12	21.04		
.50	28.96	25.02	23.45	22.47	20.96	20.86		
.25	28.91	24.78	23.20	22.29	20.74	20.64		
.12	28.89	24.58	23.03	22.13	20.58	20.38		
-.03	30.34	28.48	26.89	24.10	23.47	22.91		
-.06	29.98	28.78	27.60	24.99	24.40	23.91		
-.12	27.20	27.06	26.84	25.54	25.16	24.86		
-.25	22.42	22.72	23.00	23.30	23.33	23.34		
-.50	19.99	20.01	20.10	20.20	20.26	20.34		
-1.00	18.20	18.25	18.32	18.39	18.34	18.35		
VAPOR PRESSURE (mb)								
16.00	14.08	14.63	14.06	--	15.76	16.07		
8.00	14.24	14.80	14.20	15.70	16.06	16.04		
4.00	14.35	14.84	14.24	15.73	16.00	16.07		
2.00	14.43	14.93	14.28	15.76	16.02	16.09		
1.00	14.54	14.98	14.34	15.78	16.01	16.09		
.50	14.58	15.02	14.36	15.78	16.03	16.11		
.25	14.63	15.02	14.43	15.80	15.98	16.11		
.12	14.70	15.02	14.54	15.80	16.00	16.13		
WIND SPEED (cm/sec)								
16.00	729	627	660	801	1368	632		
8.00	639	478	501	640	1061	401		
4.00	569	380	397	554	900	416		
2.00	497	307	322	484	775	352		
1.00	432	260	279	415	661	305		
.50	373	222	230	362	576	262		
.25	299	161	173	294	457	201		
WIND DIRECTION (deg)								
1.00	--	--	--	--	--	--		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	1850	1950	2050	2353	0058	0155		
Run Time (min)	28	28	28	28	26	22		
-.03	-.84	-.87	-.68	-.27	-.20	.20		
-.06	-.51	-.52	-.53	-.30	-.17	.20		
-.12	-.02	-.09	.17	-.19	-.08	.11		
-.25	.15	.14	+.06	0	+.06	.01		
-.50	.02	.01	0	-.02	+.09	0		
-1.00	.01	.05	0	-.04	0	.02		

Precipitation (cm)	--	--	--	--	--	--

* July 11, 1956

Table 8.2 (Continued)

HOURLY OBSERVATIONS			July 11, 1956			O'NEILL, NEBRASKA		
CST	0305	0405	0505	0605	0705	0805		
RADIATION (cal/cm²sec)								
Insolation	--	--	.0001	.0020	.0058	.0078		
Reflected	--	--	--	.0003	.0014	.0013		
Net Radiation	-.0010	-.0009	-.0012	.0000	.0028	.0042		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	--	--	--	--	--	--		
8.00	21.86	21.88	22.33	22.87	23.49	24.02		
4.00	21.61	21.69	22.29	22.83	23.69	24.23		
2.00	21.30	21.58	22.12	22.80	23.87	24.35		
1.00	21.10	21.42	22.04	22.77	24.03	24.51		
.50	20.97	21.30	21.87	22.74	24.23	24.66		
.25	20.78	21.18	21.66	22.67	24.38	24.81		
.12	20.61	21.03	21.54	22.64	24.50	24.88		
-.03	22.44	22.18	22.07	21.96	22.35	23.19		
-.06	23.34	23.02	22.74	22.55	22.52	22.84		
-.12	24.48	24.13	23.80	23.56	23.30	23.07		
-.25	23.28	23.10	23.08	22.99	22.87	22.70		
-.50	20.40	20.38	20.40	20.44	20.44	20.40		
-1.00	18.36	18.34	18.32	18.33	18.31	18.28		
VAPOR PRESSURE (mb)								
16.00	16.34	16.73	17.16	17.10	18.00	18.32		
8.00	16.30	16.68	17.10	17.21	17.92	18.38		
4.00	16.35	16.71	17.15	17.39	18.09	18.56		
2.00	16.36	16.76	17.19	17.39	18.19	18.82		
1.00	16.39	16.75	17.21	17.39	18.19	18.94		
.50	16.43	16.80	17.24	17.47	18.15	18.68		
.25	16.46	16.82	17.24	17.54	18.22	19.32		
.12	16.46	16.82	17.24	17.54	18.15	19.42		
WIND SPEED (cm/sec)								
16.00	651	685	843	780	914	1090		
8.00	506	559	707	689	793	936		
4.00	429	491	628	607	704	833		
2.00	365	437	558	543	636	744		
1.00	314	383	488	474	558	649		
.50	272	327	424	411	484	570		
.25	204	267	348	340	402	468		
WIND DIRECTION (deg)								
1.00	--	--	--	--	--	--		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	0255	0351	0452	0550	0650	0750		
Run Time (min)	23	25	24	26	26	26		
-.03	.15	-.03	.08	-.11	-.20	-.26		
-.06	.07	.14	.06	+.03	-.04	-.15		
-.12	.12	.16	.10	.09	.11	+.11		
-.25	.02	.06	.04	.04	.08	.09		
-.50	.02	-.01	-.01	-.02	.02	.03		
-1.00	-.02	-.01	0	-.02	.01	0		
Precipitation (cm)	--	--	--	--	--	--		

Table 8.2 (Continued)

HOURLY OBSERVATIONS			July 11, 1956			O'NEILL, NEBRASKA		
CST	0905	1105	1305	1405	1505	1606		
RADIATION (cal/cm^2sec)								
Insolation	.0135	.0200	.0190	.0202	.0135	.0135		
Reflected	.0028	.0038	.0037	.0039	.0028	.0032		
Net Radiation	.0082	.0128	.0125	.0123	.0080	.0075		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	--	27.13	29.54	31.20	32.47	32.83		
8.00	25.06	27.27	30.00	31.67	32.83	33.38		
4.00	25.38	27.93	30.46	32.13	33.32	33.81		
2.00	25.87	29.11	31.39	32.85	34.11	34.33		
1.00	26.09	29.84	32.22	33.26	34.80	35.23		
.50	26.77	30.46	32.98	33.97	35.75	36.19		
.25	27.36	31.64	33.82	35.26	36.98	37.17		
.12	27.89	32.07	34.71	36.49	38.02	37.76		
-.03	24.42	29.29	34.30	35.52	36.46	36.00		
-.06	23.37	26.06	29.64	31.12	32.34	32.72		
-.12	23.04	23.40	24.68	25.53	26.28	27.10		
-.25	22.58	22.34	22.34	22.36	22.50	22.58		
-.50	20.41	20.37	20.46	20.34	20.38	20.26		
-1.00	18.27	18.21	18.25	18.21	18.20	18.18		
VAPOR PRESSURE (mb)								
16.00	19.11	23.21	23.14	22.62	24.01	23.55		
8.00	19.17	23.48	23.62	22.94	24.31	23.69		
4.00	19.20	23.57	23.40	23.10	24.45	23.74		
2.00	19.26	23.78	23.40	23.22	24.75	23.89		
1.00	19.34	23.98	23.54	23.34	24.94	24.10		
.50	19.51	24.31	23.73	23.57	24.90	24.15		
.25	20.05	24.64	24.06	23.85	24.91	24.55		
.12	20.21	25.07	24.58	24.26	24.88	24.75		
WIND SPEED (cm/sec)								
16.00	1068	735	670	604	486	630		
8.00	923	684	626	--	463	628		
4.00	837	634	575	533	435	596		
2.00	761	582	530	490	403	515		
1.00	663	519	471	439	360	484		
.50	585	460	416	390	320	429		
.25	527	380	350	321	261	361		
WIND DIRECTION (deg)								
1.00	--	--	--	--	--	--		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	0850	1050	1250	1350	1453	1550		
Run Time (min)	26	26	26	27	25	27		
-.03	+.87	+1.12	+.67	+.52	+.29	-.23		
-.06	+.37	+.76	+.66	+.57	+.36	+.11		
-.12	0	+.17	+.31	+.34	+.28	+.25		
-.25	-.05	-.03	0	+.01	+.03	+.07		
-.50	0	0	-.01	-.02	-.01	-.03		
-1.00	0	-.02	-.04	-.02	-.01	-.01		
Precipitation (cm)	--	--	--	--	--	--		

Table 8.2 (Continued)

HOURLY OBSERVATIONS			July 23, 1956			O'NEILL, NEBRASKA	
CST	0905	1105	1205	1305	1405	1605		
			RADIATION (cal/cm²sec)					
Insolation	.0148	.0205	.0219	.0217	.0201	.0148		
Reflected	--	--	--	--	--	--		
Net Radiation	.0080	.0118	.0130	.0130	.0117	.0078		
			AIR and SOIL TEMPERATURES (°C)					
Height (m)								
16.00	22.67	26.10	27.43	28.56	30.54	30.92		
8.00	23.18	26.83	27.89	28.83	30.91	31.22		
4.00	23.65	26.89	28.30	29.52	31.76	31.61		
2.00	24.19	27.81	29.11	30.45	32.47	32.03		
1.00	25.04	28.73	29.88	30.96	32.85	32.80		
.50	25.81	29.59	31.02	31.85	33.62	33.68		
.25	26.80	30.92	32.17	33.05	34.90	34.62		
.12	27.44	31.97	33.06	34.21	35.80	35.22		
-.03	23.44	30.35	33.22	35.40	37.20	36.63		
-.06	21.69	25.88	28.20	30.24	32.72	33.05		
-.12	21.37	22.10	22.81	23.74	25.72	26.48		
-.25	21.93	21.64	21.57	21.60	21.68	21.98		
-.50	20.65	20.60	20.54	20.54	20.36	20.37		
-1.00	19.01	18.92	18.92	18.85	18.74	18.56		
			VAPOR PRESSURE (mb)					
16.00	18.21	--	13.77	--	13.00	--		
8.00	18.47		--	--	13.91	--		
4.00	18.50	17.57	-	--	13.83	--		
2.00	18.54	17.57	-	--	13.84	--		
1.00	18.61	17.77	14.89	--	13.82	--		
.50	18.80	18.04	14.68	--	13.99	--		
.25	18.86	18.34	--	--	14.07	-		
.12	19.09	18.83	15.30	--	14.11	--		
			WIND SPEED (cm/sec)					
16.00	516	410	442	512	546	521		
8.00	409	378	424	483	511	485		
4.00	464	359	397	452	472	455		
2.00	425	342	373	428	457	423		
1.00	379	305	334	387	410	382		
.50	338	275	303	343	369	336		
.25	281	234	255	289	303	287		
			WIND DIRECTION (deg)					
1.00	180	180	170	170	200	210		
			SOIL TEMPERATURE CHANGE (°C)					
Initial Time	0850	1057	1154	1254	1354	1555		
Run Time (min)	27	25	27	20	25	30		
-.03	1.40	1.38	.89	.63	-.10	-.36		
-.06	.74	1.03	.74	.72	.36	.16		
-.12	.07	.22	.30	.49	.21	.16		
-.25	-.05	-.09	-.04	.13	.17	.25		
-.50	0	-.08	-.04	.08	-.02	.12		
-1.00	.01	-.01	-.03	0	-.02	-.01		
Precipitation (cm)	--	--	--	--	--	--		

Table 8.2 (Continued)

HOURLY OBSERVATIONS			July 23, 1956			O'NEILL, NEBRASKA		
CST	1705	1805	1905	2105	2305	0005*		
RADIATION (cal/cm²sec)								
Insolation	.0099	.0060	.0018	--	--	--		
Reflected	--	--	--	--	--	--		
Net Radiation	.0042	.0017	-.0007	-.0011	-.0014	-.0014		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	31.21	31.05	29.96	26.83	23.68	24.82		
8.00	31.48	31.27	30.04	26.49	23.13	24.26		
4.00	31.93	31.52	30.04	26.18	22.69	23.93		
2.00	32.37	31.77	30.01	26.01	22.34	23.55		
1.00	32.65	31.99	30.02	25.70	22.07	23.15		
.50	33.16	32.26	30.01	25.58	21.74	22.59		
.25	33.61	32.50	30.01	25.40	21.51	22.27		
.12	34.06	32.69	30.03	25.22	21.33	21.99		
-.03	34.40	33.20	31.31	27.98	25.27	24.66		
-.06	32.77	31.84	30.68	28.31	26.20	25.69		
-.12	26.98	27.30	27.28	26.95	26.16	26.07		
-.25	22.19	22.52	22.74	23.17	23.44	23.75		
-.50	20.31	20.38	20.32	20.32	20.38	20.65		
-1.00	18.58	18.54	18.54	18.54	18.65	18.93		
VAPOR PRESSURE (mb)								
16.00	--	--	--	15.33	15.17	16.64		
8.00	--	--	--	15.38	15.17	16.46		
4.00	--	--	--	16.26	15.17	16.50		
2.00	--	--	--	15.74	15.12	16.43		
1.00	--	-	--	15.81	15.09	16.34		
.50	--	--	--	15.53	15.13	16.30		
.25	--	--	--	15.71	15.16	16.11		
.12	--	--	--	15.58	15.15	16.11		
WIND SPEED (cm/sec)								
16.00	637	778	731	532	575	437		
8.00	600	706	635	410	474	398		
4.00	537	667	568	341	385	341		
2.00	487	--	--	278	330	288		
1.00	443	505	437	233	279	241		
.50	390	442	377	176	241	207		
.25	326	368	310	160	174	168		
WIND DIRECTION (deg)								
1.00	190	180	170	180	200	250		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	1657	1753	1850	2050	2252	2352		
Run Time (min)	20	13	27	27	33	25		
-.03	-.85	-.62	-.76	-.68	-.40	-.33		
-.06	-.35	-.38	-.48	-.58	-.43	-.31		
-.12	.37	.22	0	-.26	-.24	-.17		
-.25	-.04	.10	.12	.06	.07	0		
-.50	-.15	-.01	0	0	.07	.01		
-1.00	-.12	0	0	0	.01	-.01		
Precipitation (cm)	--	--	--	--	--	--		

* July 24, 1956

Table 8.2 (Continued)

HOURLY OBSERVATIONS			July 24, 1956			O'NEILL, NEBRASKA		
CST	0105	0205	0305	0405	0505	0605		
RADIATION (cal/cm^{2}sec)								
Insolation	--	--	--	--	.0001	.0013		
Reflected	--	--	--	--	.0000	.0003		
Net Radiation	-.0014	-.0017	-.0016	-.0017	-.0018	-.0008		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	24.34	22.55	20.96	19.83	19.64	18.74		
8.00	24.17	22.18	20.62	19.47	19.52	18.70		
4.00	23.98	21.93	20.35	19.27	19.41	18.68		
2.00	23.83	21.73	20.18	19.08	19.25	18.60		
1.00	23.65	21.47	19.96	18.95	19.13	18.50		
.50	23.30	21.23	19.62	18.68	18.95	18.43		
.25	23.05	20.91	19.32	18.48	18.89	18.34		
.12	22.80	20.64	19.02	18.33	18.62	18.26		
-.03	24.23	23.71	22.92	22.37	21.91	21.60		
-.06	25.04	24.58	24.02	23.50	23.00	22.64		
-.12	25.65	25.28	24.96	24.66	24.32	23.99		
-.25	23.76	23.75	23.70	23.70	23.62	23.52		
-.50	20.70	20.74	20.80	20.84	20.88	20.91		
-1.00	18.93	18.92	18.93	18.94	18.94	18.95		
VAPOR PRESSURE (mb)								
16.00	18.43	17.77	17.97	18.23	18.32	17.99		
8.00	18.47	17.74	17.98	18.05	18.35	18.05		
4.00	18.44	17.70	17.97	18.09	18.42	18.03		
2.00	18.41	17.61	17.98	18.17	18.45	18.05		
1.00	18.36	17.57	18.01	18.19	18.51	18.07		
.50	18.36	17.57	18.07	18.21	18.56	18.12		
.25	18.31	17.48	18.09	18.23	18.61	18.13		
.12	18.31	17.43	18.14	18.25	18.71	18.11		
WIND SPEED (cm/sec)								
16.00	669	605	530	637	642	584		
8.00	559	472	418	495	542	532		
4.00	467	415	371	435	463	505		
2.00	375	358	310	378	411	420		
1.00	321	307	273	328	378	380		
.50	294	267	229	287	330	336		
.25	246	222	197	244	281	289		
WIND DIRECTION (deg)								
1.00	320	320	320	320	320	320		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	0051	0157	0238	0350	0450	0051		
Run Time (min)	25	19	20	27	27	25		
-.03	-.12	-.26	-.31	-.20	-.12	-.11		
-.06	-.17	-.21	-.18	-.19	-.12	-.15		
-.12	-.15	-.13	-.11	-.11	-.10	-.14		
-.25	-.01	0	-.01	-.03	0	-.06		
-.50	.02	.03	.01	.03	.06	-.02		
-1.00	0	.01	0	0	.03	-.02		
Precipitation (cm)	--	--	--	--	--	--		

Table 8.2 (Continued)

HOURLY OBSERVATIONS			July 24, 1956				O'NEILL, NEBRASKA
CST	0705	0805	0905	1005	1105	1205	
RADIATION (cal/cm²sec)							
Insolation	.0048	.0095	.0143	.0182	.0212	.0225		
Reflected	.0012	.0022	.0030	.0035	.0039	.0041		
Net Radiation	.0015	.0051	.0084	.0115	.0133	.0144		
AIR and SOIL TEMPERATURES (°C)							
Height (m)							
16.00	19.75	21.48	22.78	24.58	25.64	26.77	
8.00	20.95	21.87	23.09	24.90	26.05	27.03	
4.00	20.05	22.13	23.50	25.26	26.60	27.87	
2.00	20.20	22.48	24.02	26.04	27.23	28.66	
1.00	20.35	22.73	24.66	26.91	28.16	29.74	
.50	20.42	23.20	25.08	27.68	29.11	30.38	
.25	20.59	23.66	25.77	28.44	29.80	31.31	
.12	20.67	23.98	26.30	28.83	30.52	32.02	
-.03	21.70	22.75	24.72	27.44	30.20	32.65	
-.06	22.38	22.66	23.47	24.84	26.57	28.38	
-.12	23.66	23.43	23.30	23.38	23.74	24.30	
-.25	23.37	23.29	23.16	23.04	22.90	22.85	
-.50	20.90	20.97	20.98	21.00	21.00	20.98	
-1.00	18.94	18.96	18.95	18.84	18.87	18.85	
VAPOR PRESSURE (mb)							
16.00	17.98	18.21	17.91	16.93	15.96	12.24	
8.00	18.05	18.36	18.00	17.10	15.96	12.74	
4.00	18.00	18.34	18.04	17.15	16.12	12.74	
2.00	18.03	18.37	18.01	17.14	16.08	12.68	
1.00	18.09	18.43	18.07	17.25	16.19	12.70	
.50	18.13	18.48	18.19	17.39	16.23	12.71	
.25	18.12	18.48	18.21	17.48	16.20	12.83	
.12	18.21	18.57	18.30	17.68	16.17	12.88	
WIND SPEED (cm/sec)							
16.00	843	905	929	959	974	918	
8.00	763	828	856	904	889	863	
4.00	708	719	723	756	745	765	
2.00	609	608	614	662	658	679	
1.00	552	532	540	585	585	613	
.50	501	475	492	537	538	569	
.25	426	412	416	455	455	502	
WIND DIRECTION (deg)							
1.00	340	340	340	340	340	340	
SOIL TEMPERATURE CHANGE (°C)							
Initial Time	0651	•0750	0851	0951	1050	1150	
Run Time (min)	25	27	26	25	29	30	
-.03	.20	.70	.97	1.05	1.27	.88	
-.06	-.03	.29	.46	.61	.75	.74	
-.12	-.14	-.06	.03	.09	.21	.29	
-.25	-.06	-.02	-.04	-.05	-.05	-.04	
-.50	-.01	.06	.02	0	0	-.01	
-1.00	-.01	.01	0	-.02	-.02	-.02	

Precipitation (cm)	--	--	--	--	--	--

Table 8.2 (Continued)

HOURLY OBSERVATIONS	July 24, 1956				O'NEILL, NEBRASKA			
CST	1305	1405	1505	1605	1805	1905		
			RADIATION (cal/cm^{2}sec)					
Insolation	.0222	.0208	.0183	.0150	.0063	.0019		
Reflected	.0041	.0039	.0034	.0030	.0017	--		
Net Radiation	.0142	.0127	.0109	.0080	.0014	-.0011		
			AIR and SOIL TEMPERATURES (°C)					
Height (m)								
16.00	27.71	28.60	28.92	29.04	29.09	28.45		
8.00	28.11	28.83	29.39	29.63	29.19	28.51		
4.00	28.75	29.50	30.07	30.12	29.54	28.54		
2.00	29.93	30.08	30.74	30.83	29.82	28.56		
1.00	30.35	31.11	31.44	31.24	30.08	28.59		
.50	31.32	32.05	32.17	31.84	30.36	28.60		
.25	32.54	32.94	33.08	32.42	30.72	28.65		
.12	33.36	33.77	33.98	33.26	31.17	28.63		
-.03	34.60	36.12	36.74	36.43	33.54	31.58		
-.06	30.03	31.45	32.52	32.95	32.03	30.99		
-.12	24.98	25.77	26.47	27.17	28.04	28.08		
-.25	22.84	22.94	23.03	23.20	23.45	23.69		
-.50	20.98	21.03	21.01	20.99	20.87	20.85		
-1.00	18.82	18.84	18.80	18.75	18.87	18.87		
			VAPOR PRESSURE (mb)					
16.00	11.17	10.96	11.29	16.51	16.46	12.26		
8.00	11.82	11.65	11.89	16.88	16.61	12.38		
4.00	11.84	11.68	12.00	16.88	16.51	12.38		
2.00	11.66	11.65	11.76	16.84	16.45	12.36		
1.00	11.78	11.68	11.79	16.76	16.44	12.35		
.50	11.90	12.19	11.93	16.81	16.46	12.26		
.25	12.24	12.76	11.93	16.92	16.57	12.36		
.12	12.33	12.84	12.21	17.14	16.57	12.36		
			WIND SPEED (cm/sec)					
16.00	856	790	825	657	487	503		
8.00	793	707	745	588	433	427		
4.00	736	688	704	566	426	398		
2.00	657	611	618	501	376	339		
1.00	595	540	554	444	337	291		
.50	540	485	507	401	296	259		
.25	477	420	434	353	264	224		
			WIND DIRECTION (deg)					
1.00	340	340	--	--	--	--		
			SOIL TEMPERATURE CHANGE (°C)					
Initial Time	1250	1350	1450	1554	1752	1850		
Run Time (min)	27	27	26	27	25	26		
-.03	.64	.45	.01	-.43	-.83	-.93		
-.06	.74	.46	.30	.06	-.33	-.52		
-.12	.32	.30	.30	.28	.05	-.02		
-.50	.01	.02	.03	.09	.10	+.06		
-1.00	-.01	0	-.02	0	.01	0		
Precipitation (cm)	--	--	--	--	--	--		

Table 8.2 (Continued)

HOURLY OBSERVATIONS			July 24, 1956			O'NEILL, NEBRASKA		
CST	2005	2105	2205	2305	0005*	0105*		
RADIATION (cal/cm^2sec)								
Insolation	.0002	--	--	--	--	--		
Reflected	--	--	--	--	--	--		
Net Radiation	-.0015	-.0012	-.0011	-.0010	-.0011	-.0009		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	27.19	26.40	25.42	23.66	22.44	21.26		
8.00	26.47	24.39	23.13	22.37	21.29	19.58		
4.00	25.28	22.98	21.83	20.73	19.43	17.15		
2.00	23.83	21.71	19.63	19.17	17.62	15.94		
1.00	22.94	20.23	17.27	16.31	16.54	14.54		
.50	21.68	18.52	16.01	14.68	15.76	13.05		
.25	21.02	17.49	15.42	13.73	15.26	12.13		
.12	20.26	16.30	14.81	13.02	14.77	11.56		
-.03	29.13	26.72	25.05	23.70	22.64	21.70		
-.06	29.62	28.04	26.68	25.49	24.48	23.62		
-.12	27.94	27.63	27.21	26.09	26.14	--		
-.25	23.95	24.19	24.33	24.42	24.44	24.46		
-.50	20.95	21.05	21.08	21.10	21.16	21.24		
-1.00	18.91	18.95	19.00	19.04	19.08	19.16		
VAPOR PRESSURE (mb)								
16.00	12.36	12.93	12.40	13.18	13.74	13.16		
8.00	12.28	12.64	12.46	13.18	13.58	12.89		
4.00	12.26	12.42	12.46	13.29	13.55	12.76		
2.00	12.22	12.28	12.38	13.25	13.56	12.71		
1.00	12.20	12.19	12.22	13.10	13.52	12.67		
.50	12.33	12.08	11.99	13.08	13.34	12.66		
.25	12.22	11.98	11.96	13.08	13.15	12.64		
.12	12.18	11.97	11.94	13.13	12.98	12.96		
WIND SPEED (cm/sec)								
16.00	417	442	448	478	512	521		
8.00	317	270	387	395	414	378		
4.00	250	172	301	291	302	230		
2.00	146	115	216	217	202	178		
1.00	85	69	130	126	137	116		
.50	36	21	79	69	92	48		
.25	26	18	27	16	45	16		
WIND DIRECTION (deg)								
1.00	--	--	--	--	--	180		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	1951	2052	2150	2250	2353	0053		
Run Time (min)	26	25	27	27	25	31		
-.03	-1.10	-.83	-.66	-.57	-.34	-.49		
-.06	-.73	-.64	-.57	-.50	-.39	-.47		
-.12	-.19	-.16	-.20	-.28	-.22	--		
-.25	.17	.04	.05	-.01	-.01	-.11		
-.50	.11	-.01	.03	0	0	-.03		
-1.00	0	.01	.02	-.01	.02	.02		
Precipitation (cm)	--	--	--	--	--	--		

* July 25, 1956

Table 8.2 (Continued)

HOURLY OBSERVATIONS			July 25, 1956			O'NEILL, NEBRASKA		
CST	0205	0305	0405	0505	0605	0705		
RADIATION (cal/cm²sec)								
Insolation	--	--	--	.0000	.0017	.0057		
Reflected	--	--	--	.0000	.0006	.0016		
Net Radiation	-.0009	-.0008	-.0012	-.0011	-.0004	.0022		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	20.05	18.35	18.15	17.65	17.14	19.22		
8.00	18.51	15.34	16.34	15.56	16.67	19.40		
4.00	15.78	14.13	15.07	14.04	16.52	19.56		
2.00	14.60	13.73	14.47	13.25	16.41	19.75		
1.00	13.61	13.38	14.00	12.86	16.36	20.09		
.50	12.56	11.91	13.06	12.45	16.27	20.33		
.25	11.77	10.73	13.34	12.13	16.24	20.69		
.12	11.04	9.86	13.01	11.89	16.19	20.87		
-.03	21.24	19.94	19.47	19.21	18.99	19.82		
-.06	22.78	22.04	21.40	20.90	20.31	20.64		
-.12	25.06	24.56	24.07	23.60	23.14	22.82		
-.25	24.30	24.18	24.06	23.90	23.69	23.57		
-.50	21.24	21.26	21.30	21.29	21.32	21.34		
-1.00	19.15	19.16	19.18	19.16	19.08	19.09		
VAPOR PRESSURE (mb)								
16.00	13.27	13.13	--	--	--	14.65		
8.00	12.33	12.01	--	--	--	14.87		
4.00	12.23	11.95	--	--	--	14.79		
2.00	12.20	11.82	--	--	--	14.86		
1.00	12.28	11.79	--	--	--	14.87		
.50	12.30	11.83	--	--	--	14.92		
.25	12.36	11.89	--	--	--	14.98		
.12	12.63	12.27	--	--	--	15.05		
WIND SPEED (cm/sec)								
16.00	521	458	599	538	646	521		
8.00	398	217	442	414	514	512		
4.00	229	118	301	267	426	466		
2.00	153	79	230	191	365	439		
1.00	95	55	174	137	322	390		
.50	32	45	140	97	278	335		
.25	16	16	94	55	220	271		
WIND DIRECTION (deg)								
1.00	180	190	190	190	180	190		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	0152	0252	0352	0453	0550	0650		
Run Time (min)	32	24	24	24	28	26		
-.03	-.51	-.25	-.06	-.14	.11	+.56		
-.06	-.43	-.32	-.12	-.17	-.58	.12		
-.12	-.30	-.21	-.22	-.14	-.16	-.18		
-.25	-.05	-.07	-.05	-.01	-.06	-.10		
-.50	.01	-.01	.03	0	.03	-.01		
-1.00	0	0	.03	.01	0	-.01		
Precipitation (cm)	--	--	--	--	--	--		

Table 8.2 (Continued)

HOURLY OBSERVATIONS			July 25, 1956			O'NEILL, NEBRASKA		
CST	0805	0905	1005	1205	1405	1505		
RADIATION (cal/cm²sec)								
Insolation	.0085	.0056	(.0126)	.0230	.0203	.0180		
Reflected	.0020	.0012	.0025	.0044	.0038	.0033		
Net Radiation	.0042	.0023	.0069	.0142	.0128	.0108		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	21.95	23.96	25.37	28.91	31.40	32.63		
8.00	22.27	24.25	25.82	29.72	32.15	33.35		
4.00	22.68	24.39	26.27	30.44	32.87	34.01		
2.00	22.96	24.64	26.90	31.13	33.63	34.70		
1.00	23.17	24.83	27.43	31.75	34.40	35.31		
.50	23.64	24.95	27.98	32.80	35.18	35.80		
.25	24.06	25.17	28.55	34.06	36.07	36.55		
.12	24.27	25.35	28.81	34.96	36.82	37.35		
-.03	21.41	23.58	25.58	31.46	35.05	35.69		
-.06	21.19	22.30	23.38	26.50	30.32	31.22		
-.12	22.52	22.44	22.57	23.24	24.66	25.58		
-.25	23.31	23.09	22.91	22.62	22.56	22.60		
-.50	21.31	21.27	21.85	21.15	21.11	21.02		
-1.00	19.05	19.01	19.02	18.97	18.92	18.89		
VAPOR PRESSURE (mb)								
16.00	14.69	15.09	15.20	13.22	13.75	13.28		
8.00	14.79	15.23	15.37	13.68	13.95	13.44		
4.00	14.83	15.24	15.38	13.76	13.99	13.48		
2.00	14.89	15.32	15.42	13.97	14.05	13.54		
1.00	14.89	15.38	15.48	14.04	14.11	13.58		
.50	14.96	15.46	15.51	14.30	14.17	13.64		
.25	15.00	15.47	15.60	14.38	14.21	13.67		
.12	15.09	15.50	15.73	14.57	14.30	13.90		
WIND SPEED (cm/sec)								
16.00	786	819	776	1053	1289	1145		
8.00	717	753	--	1009	1217	1103		
4.00	652	684	662	878	1073	994		
2.00	547	624	616	841	975	901		
1.00	522	550	545	732	864	785		
.50	460	474	--	648	740	688		
.25	375	388	393	534	614	563		
WIND DIRECTION (deg)								
1.00	180	180	170	160	165	180		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	0750	0854	0951	1151	1350	1450		
Run Time (min)	26	24	28	27	28	28		
-.03	.73	.45	.90	1.03	.48	.02		
-.06	.30	.52	.63	.75	.58	.27		
-.12	-.13	.02	.07	.21	.33	.31		
-.25	-.11	-.08	-.09	-.05	.01	.05		
-.50	-.02	0	-.01	-.02	-.02	0		
-1.00	-.04	.02	-.01	-.02	0	0		
Precipitation (cm)	--	--	--	--	--	--		

Table 8.2 (Continued)

HOURLY OBSERVATIONS			July 25, 1956			O'NEILL, NEBRASKA		
CST	1605	1705	1805	1905	2005	2105		
RADIATION (cal/cm²sec)								
Insolation	.0145	.0090	.0045	.0011	.0001	--		
Reflected	.0028	.0020	.0010	--	--	--		
Net Radiation	.0080	.0040	.0006	-.0015	-.0017	-.0011		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	32.66	33.42	33.14	31.97	29.63	28.91		
8.00	33.32	33.68	33.26	31.87	29.52	28.86		
4.00	33.79	34.01	33.36	31.79	29.42	28.76		
2.00	34.45	34.38	33.40	31.68	29.21	28.68		
1.00	34.96	34.72	33.49	31.61	29.03	28.62		
.50	35.40	35.02	33.56	31.50	28.85	28.52		
.25	36.17	35.34	33.62	31.38	28.66	28.34		
.12	36.78	35.62	33.68	31.28	28.50	28.25		
-.03	35.28	34.46	32.69	31.28	29.64	28.34		
.06	31.64	31.71	31.10	30.26	29.30	28.28		
-.12	26.22	26.84	27.14	27.22	27.18	20.96		
-.25	22.70	22.09	23.17	23.37	23.60	23.78		
-.50	20.98	21.06	21.04	21.04	21.06	21.10		
-1.00	18.88	18.99	18.98	18.98	19.01	19.04		
VAPOR PRESSURE (mb)								
16.00	14.01	13.05	13.13	13.80	14.37	14.51		
8.00	14.20	13.12	13.27	13.94	14.43	14.61		
4.00	14.24	13.21	13.26	13.85	14.49	14.60		
2.00	14.31	13.26	13.28	13.94	14.38	14.53		
1.00	14.35	13.29	13.35	13.86	14.48	14.62		
.50	14.39	13.33	13.32	13.97	14.45	14.59		
.25	14.42	13.40	13.32	13.94	14.49	14.59		
.12	14.49	13.46	13.33	13.84	14.39	14.50		
WIND SPEED (cm/sec)								
16.00	1260	1236	1174	948	920	972		
8.00	1179	1193	1073	821	803	863		
4.00	1046	1044	944	727	714	770		
2.00	955	959	853	650	614	683		
1.00	830	826	744	565	541	587		
.50	722	789	652	490	475	520		
.25	591	588	534	405	386	419		
WIND DIRECTION (deg)								
1.00	170	180	170	160	160	160		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	1550	1650	1752	1851	1951	2053		
Run Time (min)	26	26	24	25	26	27		
-.03	-.12	.63	.74	-.74	-.50	-.30		
-.06	.03	-.12	-.33	-.32	-.39	-.31		
-.12	.26	.13	.09	+.02	-.05	-.07		
-.25	+.07	+.10	.10	.08	.10	.07		
-.50	-.02	-.02	.01	0	.04	.01		
-1.00	-.01	0	.03	.02	.04	0		

Precipitation (cm)	--	--	--	--	--	--

Table 8.2 (Continued)

HOURLY OBSERVATIONS	July 25, 1956				O'NEILL, NEBRASKA		
CST	2305	0005*	0205*	0305*	0405*	0505*	
RADIATION (cal/cm²sec)							
Insolation	--	--	--	--	--	.0000	
Reflected	--	--	--	--	--	.0000	
Net Radiation	-.0014	-.0014	-.0009	-.0012	-.0011	-.0007	
AIR and SOIL TEMPERATURES (°C)							
Height (m)							
16.00	27.72	26.75	26.37	25.65	25.07	24.02	
8.00	27.63	26.70	26.38	25.56	24.83	23.48	
4.00	27 51	26.60	26.34	25.30	24.63	22.79	
2.00	27.43	26.42	26.23	25.16	24.45	22.03	
1.00	27.35	26.32	26.16	24.89	24.20	21.31	
.50	27.23	26.22	26.09	24.69	24.07	20.65	
.25	27.11	26.05	26.00	24.42	23.94	20.27	
.12	27.03	25.93	25.91	24.25	23.78	20.02	
-.03	27.16	26.32	25.44	25.26	24.75	24.02	
-.06	27 14	26.57	25.69	25.44	25.09	24.67	
-.12	26.46	26.11	25.78	25.48	25.26	25.07	
-.25	23.98	24.06	24.17	24.15	24.10	24.05	
-.50	21.14	21.17	21.33	21.34	21.37	21.42	
-1.00	19.05	19.08	19.19	19.19	19 20	19.21	
VAPOR PRESSURE (mb)							
16.00	15.29	15.81	17.73	15.75	15.38	14.55	
8.00	15.23	15.87	17.75	15.84	15.48	14.99	
4.00	15.24	15.81	17 75	15 88	15.46	15.05	
2.00	15.28	15.82	17.73	15.87	15.50	15.16	
1.00	15.31	15.80	17.73	15.88	15.48	15.16	
.50	15.22	15.81	17.75	15.98	15.54	15.18	
.25	15.26	15.77	17.77	15.92	15.48	15.13	
.12	15.28	15.75	17.84	15.97	15.60	15.18	
WIND SPEED (cm/sec)							
16.00	1084	1041	968	581	607	341	
8.00	931	933	954	527	550	287	
4.00	864	814	853	432	457	238	
2.00	724	739	757	400	411	191	
1.00	636	639	655	342	351	150	
.50	561	557	576	295	299	120	
.25	463	454	469	236	242	72	
WIND DIRECTION (deg)							
1.00	150	170	190	215	210	250	
SOIL TEMPERATURE CHANGE (°C)							
Initial Time	2253	2350	0150	0250	0350	0450	
Run Time (min)	23	26	28	26	25	28	
-.03	.23	-.24	.01	-.27	-.17	-.38	
-.06	-.18	- 11	-.13	-.14	-.13	-.20	
-.12	-.11	-.11	.01	-.12	-.06	-.08	
-.25	.02	.05	.03	-.04	-.01	-.02	
-.50	0	0	.01	0	0	0	
-1.00	.02	.01	0	0	-.01	0	

Precipitation (cm)	--	--	--	--	--	--

* July 26, 1956

Table 8.2 (Continued)

HOURLY OBSERVATIONS	July 26, 1956			O'NEILL, NEBRASKA			
CST	0605	0705	0805	0905	1005	1805*	
RADIATION (cal/cm²sec)							
Insolation	.0016	.0050	.0060	.0150	.0155	.0035	
Reflected	.0006	.0013	.0013	.0030	.0030	--	
Net Radiation	-.0002	.0019	.0027	.0080	.0090	.0009	
AIR and SOIL TEMPERATURES (°C)							
Height (m)							
16.00	23.44	24.78	26.74	29.84	32.45	29.29	
8.00	22.52	24.90	26.85	30.07	32.68	29.35	
4.00	21.78	25.10	26.98	30.26	33.21	29.38	
2.00	21.23	25.28	27.19	30.83	33.63	29.35	
1.00	20.93	25.45	27.57	31.42	34.18	29.38	
.50	20.74	25.74	27.93	32.10	34.98	29.40	
.25	20.78	25.99	28.25	33.08	36.00	29.42	
.12	20.78	26.22	28.57	33.81	36.82	29.48	
-.03	23.41	23.71	24.76	26.58	30.15	28.71	
-.06	24.21	23.96	24.24	24.89	26.68	28.68	
-.12	24.88	24.62	24.38	24.26	24.29	26.38	
-.25	24.03	23.94	23.83	23.70	23.54	23.76	
-.50	21.45	21.45	21.44	21.42	21.36	22.06	
-1.00	19.21	19.21	19.20	19.19	19.15	19.91	
VAPOR PRESSURE (mb)							
16.00	15.05	14.49	14.39	13.88	13.38	14.34	
8.00	15.27	14.55	14.45	14.02	13.57	14.89	
4.00	15.38	14.59	14.50	14.04	13.56	15.07	
2.00	15.50	14.63	14.66	14.11	13.63	15.21	
1.00	15.54	14.67	14.77	14.21	13.77	15.44	
.50	15.58	14.72	14.89	14.37	14.09	15.58	
.25	15.62	14.79	15.01	14.68	14.22	15.71	
.12	15.73	14.96	15.26	15.16	14.33	15.76	
WIND SPEED (cm/sec)							
16.00	306	364	311	430	319	726	
8.00	264	372	326	415	328	680	
4.00	212	346	301	374	308	612	
2.00	179	324	281	371	277	537	
1.00	146	287	248	331	253	471	
.50	121	272	180	296	234	411	
.25	86	206	174	246	198	332	
WIND DIRECTION (deg)							
1.00	180	210	200	235	320	160	
SOIL TEMPERATURE CHANGE (°C)							
Initial Time	0550	0650	0750	0852	0952	1750	
Run Time (min)	26	28	28	24	26	27	
-.03	-.24	.46	.49	1.20	1.46	-.74	
-.06	-.20	.05	.17	.40	.85	-.43	
-.12	-.10	-.15	-.08	-.02	.06	.05	
-.25	-.01	-.04	-.04	-.05	-.05	.05	
-.50	0	0	0	-.01	-.03	-.01	
-1.00	0	0	0	0	0	00	
Precipitation (cm)	--	--	--	--	--	--	

* August 6, 1956

Table 8.2 (Continued)

HOURLY OBSERVATIONS	August 6, 1956			O'NEILL, NEBRASKA			
CST	1905	2105	2205	2305	0005*	0305*		
RADIATION (cal/cm²sec)								
Insolation	.0015	--	--	--	--	--		
Reflected	--	--	--	--	--	--		
Net Radiation	.0007	-.0012	-.0011	rain	-.0007	-.0013		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	28.18	24.70	22.25	21.67	21.06	17.54		
8.00	28.00	23.67	22.10	21.63	21.05	17.61		
4.00	27.94	22.85	21.90	21.58	21.09	17.61		
2.00	27.78	22.44	21.87	21.53	21.03	17.58		
1.00	27.56	21.97	21.77	21.44	21.02	17.54		
.50	27.42	21.54	21.59	21.34	20.96	17.50		
.25	27.25	21.25	21.45	21.26	20.90	17.47		
.12	27.14	21.01	21.28	21.20	20.88	17.46		
-.03	27.12	23.88	22.96	22.84	22.71	20.57		
-.06	27.64	25.22	24.30	23.80	23.52	21.86		
-.12	26.38	25.86	25.49	25.13	24.70	23.73		
-.25	23.89	24.07	24.15	24.22	24.18	23.83		
-.50	22.06	22.01	22.06	22.11	22.16	22.06		
-1.00	19.93	19.96	20.00	20.11	20.02	20.01		
VAPOR PRESSURE (mb)								
16.00	13.47	15.06	22.93	rain	rain	20.27		
8.00	13.85	15.54	22.55	rain	rain	19.59		
4.00	14.02	15.90	22.58	rain	rain	19.59		
2.00	14.14	16.11	22.51	rain	rain	19.51		
1.00	14.24	16.31	22.45	rain	rain	19.50		
.50	14.32	16.42	22.45	rain	rain	19.59		
.25	14.38	16.52	22.33	rain	rain	19.27		
.12	14.45	16.58	22.39	rain	rain	19.63		
WIND SPEED (cm/sec)								
16.00	630	402	651	549	779	780		
8.00	528	367	544	457	697	700		
4.00	464	308	498	425	660	638		
2.00	404	244	437	374	565	574		
1.00	354	196	386	327	491	--		
.50	305	166	337	286	428	437		
.25	247	131	281	235	360	371		
WIND DIRECTION (deg)								
1.00	165	80	60	55	75	50		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	1850	2050	2150	2250	2350	0250		
Run Time (min)	27	28	27	27	26	26		
-.03	-.05	-.50	-.31	-.04	.11	-.29		
-.06	-.45	-.46	-.41	-.14	00	-.29		
-.12	-.05	-.14	-.22	-.18	-.14	-.19		
-.25	.04	.06	00	-.01	.06	-.14		
-.50	-.01	.02	00	00	.09	-.06		
-1.00	00	.03	+.03	.02	00	-.02		
Precipitation (cm)	--	--	--	--	--	--		

*August 7, 1956

Table 8.2 (Continued)

HOURLY OBSERVATIONS			August 7, 1956			O'NEILL, NEBRASKA	
CST	0405	0505	0605	0705	0805	0905	
RADIATION (cal/cm²sec)							
Insolation	--	.0000	.0005	.0048	.0092	.0125	
Reflected	--	--	--	--	--	--	
Net Radiation	-.0014	-.0012	-.0009	.0019	.0055	.0068	
AIR and SOIL TEMPERATURES (°C)							
Height (m)							
16.00	17.76	17.19	16.82	18.28	20.67	22.60	
8.00	17.83	17.11	16.70	18.41	20.96	22.93	
4.00	17.75	17.00	16.57	18.55	21.22	23.15	
2.00	17.69	16.90	16.45	18.66	21.49	23.41	
1.00	17.62	16.80	16.37	18.75	21.73	23.74	
.50	17.51	16.69	16.24	18.84	22.03	23.96	
.25	17.40	16.57	16.18	18.98	22.34	24.25	
.12	17.57	16.53	16.13	19.08	22.70	24.57	
-.03	20.17	19.51	18.92	19.04	20.14	21.64	
-.06	21.41	20.91	20.38	20.09	20.41	21.31	
-.12	23.40	23.09	22.75	22.41	22.16	22.06	
-.25	23.75	23.67	23.56	23.42	23.28	23.13	
-.50	22.06	22.10	22.08	22.06	22.04	22.04	
-1.00	20.03	20.03	20.04	20.02	20.01	20.00	
VAPOR PRESSURE (mb)							
16.00	18.64	17.60	17.43	17.86	17.75	18.07	
8.00	18.62	17.53	18.02	18.14	18.11	18.19	
4.00	18.56	17.53	18.13	18.23	18.23	18.32	
2.00	18.64	17.56	18.08	18.37	18.42	18.49	
1.00	18.67	17.61	18.07	18.56	18.61	18.68	
.50	18.75	17.72	18.06	18.77	18.94	18.91	
.25	18.76	17.75	17.98	19.12	19.22	19.25	
.12	19.02	17.94	17.82	19.21	19.52	19.47	
WIND SPEED (cm/sec)							
16.00	698	623	580	583	694	1218	
8.00	617	553	509	535	660	1134	
4.00	577	511	455	512	606	1040	
2.00	498	436	385	456	542	915	
1.00	439	--	--	431	500	835	
.50	410	331	289	370	420	693	
.25	319	279	242	290	340	603	
WIND DIRECTION (deg)							
1.00	75	85	85	50	110	140	
SOIL TEMPERATURE CHANGE (°C)							
Initial Time	0355	0450	0551	0652	0751	0851	
Run Time (min)	21	26	25	24	25	25	
-.03	-.30	-.14	-.06	.18	.72	.61	
-.06	-.19	.78	-.08	-.05	.27	.41	
-.12	-.11	-.13	-.07	-.11	-.05	00	
-.25	00	-.06	-.01	-.05	-.04	-.06	
-.50	.01	.01	.04	-.02	.02	-.03	
-1.00	.01	00	.10	-.04	.03	-.02	
Precipitation (cm)	--	--	--	--	--	--	

Table 8.2 (Continued)

HOURLY OBSERVATIONS			August 7, 1956			O'NEILL, NEBRASKA		
CST	1005	1105	1205	1405	1605	1705		
RADIATION (cal/cm²sec)								
Insolation	.0145	.0192	.0150	.0100	.0150	.0097		
Reflected	--	--	--	--	--	--		
Net Radiation	.0102	0130	.0110	.0135	.0103	.0054		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	23.05	25.97	27.47	27.74	29.83	28.58		
8.00	24.24	26.34	27.89	28.38	30.26	28.86		
4.00	24.58	26.82	28.34	28.92	30.52	29.23		
2.00	24.94	27.49	28.66	29.37	31.00	29.62		
1.00	25.32	28.24	29.27	29.93	31.36	29.95		
.50	25.83	28.77	29.84	30.78	31.85	30.46		
.25	26.39	20.25	30.39	31.62	32.47	30.73		
.12	26.67	30.30	30.89	32.02	32.90	31.15		
-.03	23.09	25.80	27.62	30.24	31.12	30.65		
-.06	21.71	23.80	25.54	28.18	29.48	29.53		
-.12	22.13	22.32	22.81	24.24	25.52	25.97		
-.25	22.94	22.76	22.70	22.68	22.96	23.12		
-.50	21.09	21.92	21.92	21.86	21.88	21.87		
-1.00	19.98	19.92	19.96	19.94	19.98	19.98		
VAPOR PRESSURE (mb)								
16.00	18.48	17.77	18.80	17.42	17.12	19.50		
8.00	18.97	18.17	19.14	17.80	17.38	19.82		
4.00	19.10	18.19	19.13	17.97	17.54	20.02		
2.00	19.42	18.34	19.25	18.12	17.69	20.16		
1.00	19.62	18.63	19.64	18.29	17.85	20.27		
.50	19.96	18.91	19.79	18.59	18.02	20.44		
.25	20.33	19.36	20.14	18.79	18.24	20.60		
.12	20.59	19.65	20.64	18.97	18.46	20.87		
WIND SPEED (cm/sec)								
16.00	991	838	865	1348	1379	992		
8.00	874	754	773	1251	1290	923		
4.00	878	707	718	1135	1165	841		
2.00	764	609	651	1004	1025	739		
1.00	710	554	595	908	923	669		
.50	404	470	509	768	773	560		
.25	340	385	405	640	630	464		
WIND DIRECTION (deg)								
1.00	145	155	175	155	150	155		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	0952	1052	1150	1350	1550	1650		
Run Time (min)	24	25	27	27	26	28		
-.03	-.61	1.00	.61	.43	-.19	-.38		
-.06	1.41	.79	.54	.27	.07	-.04		
-.12	.67	.13	.24	.36	.21	.18		
-.25	-.05	-.08	-.07	.02	.07	.11		
-.50	-.02	-.03	-.04	00	-.01	.04		
-1.00	.01	-.03	-.04	.01	.01	.04		
Precipitation (cm)	--	--	.	.	..	--		

Table 8.2 (Continued)

HOURLY OBSERVATIONS			August 7, 1956			O'NEILL, NEBRASKA		
CST	1805	1905	2005	2105	2205	0005*		
RADIATION (cal/cm²sec)								
Insolation	.0050	.0009	.0000	--	--	--		
Reflected	--	--	--	--	--	--		
Net Radiation	.0023	-.0009	-.0012	-.0010	-.0008	-.0014		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	28.29	27.08	25.79	24.96	23.91	22.78		
8.00	28.50	27.03	25.46	24.29	23.56	22.62		
4.00	28.62	26.95	25.13	23.70	23.12	22.48		
2.00	28.77	26.84	24.96	23.25	22.82	22.27		
1.00	28.93	26.77	24.77	22.97	22.52	22.19		
.50	29.12	26.65	24.57	22.59	22.17	22.03		
.25	29.31	26.54	24.38	22.43	22.02	21.87		
.12	29.50	26.48	24.22	22.33	21.88	21.75		
-.03	29.33	27.82	26.28	25.11	24.15	22.98		
-.06	28.96	28.09	27.02	26.02	25.16	23.04		
-.12	26.23	26.29	26.19	25.93	25.59	24.89		
-.25	23.30	23.50	23.64	23.80	23.90	23.98		
-.50	21.85	21.89	21.86	21.90	21.91	21.93		
-1.00	20.00	20.04	20.05	20.06	20.08	20.10		
VAPOR PRESSURE (mb)								
16.00	19.62	19.84	19.31	19.89	19.75	18.42		
8.00	19.77	20.00	19.50	20.01	20.06	18.59		
4.00	19.84	20.01	19.60	20.12	20.25	18.60		
2.00	19.89	20.10	19.62	20.11	20.26	18.62		
1.00	20.02	20.13	19.64	20.13	20.27	18.66		
.50	20.11	20.22	19.75	20.21	20.39	18.74		
.25	20.22	20.22	19.76	20.14	20.36	18.74		
.12	20.27	20.31	19.87	20.22	20.39	18.78		
WIND SPEED (cm/sec)								
16.00	714	697	632	440	378	932		
8.00	668	634	521	349	298	833		
4.00	615	554	439	267	238	745		
2.00	544	491	376	214	191	652		
1.00	500	447	342	177	163	589		
.50	423	378	280	139	128	491		
.25	350	314	232	102	92	399		
WIND DIRECTION (deg)								
1.00	145	135	145	105	75	150		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	1750	1850	1950	2050	2155	2353		
Run Time (min)	26	26	26	26	21	23		
-.03	-.47	-.66	-.53	-.44	-.26	-.22		
-.06	-.31	-.42	-.42	-.40	-.31	-.18		
-.12	.07	-.02	-.09	-.17	-.15	-.11		
-.25	.08	.09	-.03	.06	.04	-.01		
-.50	.02	00	-.00	00	00	-.02		
-1.00	00	00	-.01	00	-.01	-.01		
Precipitation (cm)	--	--	--	--	--	--		

*August 8, 1956

Table 8.2 (Continued)

HOURLY OBSERVATIONS			August 8, 1957				O'NEILL, NEBRASKA	
CST	0105	0205	0305	0405	0505	0605		
			RADIATION (cal/cm^{2}sec)					
Insolation	--	--	--	--	.0000	.0005		
Reflected	--	--	--	--	--	--		
Net Radiation	-.0015	-.0007	-.0014	-.0015	-.0011	-.0004		
			AIR and SOIL TEMPERATURES (°C)					
Height (m)								
16.00	23.12	18.76	17.77	17.15	16.51	17.17		
8.00	22.89	18.83	17.58	16.70	16.11	17.11		
4.00	22.58	18.85	17.41	16.45	15.81	17.05		
2.00	22.33	18.86	17.30	16.21	15.57	16.95		
1.00	22.07	18.86	17.17	16.00	15.44	16.89		
.50	21.73	18.85	17.00	15.77	15.22	16.81		
.25	21.41	18.83	16.86	15.60	15.12	16.73		
.12	21.20	18.82	16.77	15.43	15.02	16.65		
-.03	22.37	21.89	21.08	20.12	19.16	19.10		
-.06	23.52	22.96	22.43	21.75	21.00	20.48		
-.12	24.74	24.34	24.02	23.70	23.29	22.84		
-.25	23.94	23.87	23.8[illegible]	23.73	23.62	23.44		
-.50	21.95	21.95	21.95	21.96	21.95	21.90		
-1.00	20.10	20.09	20.08	20.08	20.06	20.04		
			VAPOR PRESSURE (mb)					
16.00	17.30	15.20	15.21	15.21	15.71	16.40		
8.00	17.43	15.29	15.25	14.89	15.52	16.42		
4.00	17.51	15.30	15.30	14.95	15.54	16.49		
2.00	17.59	15.31	15.31	14.99	15.52	16.62		
1.00	17.59	15.32	15.31	15.01	15.55	16.71		
.50	17.68	15.34	15.34	15.06	15.57	16.72		
.25	17.74	15.35	15.36	15.06	15.58	16.76		
.12	17.75	15.36	15.36	15.15	15.75	16.77		
			WIND SPEED (cm/sec)					
16.00	479	1190	547	532	470	558		
8.00	438	997	451	445	377	494		
4.00	395	915	397	375	310	440		
2.00	340	812	344	311	255	379		
1.00	313	729	311	283	229	349		
.50	255	633	256	233	186	294		
.25	214	533	201	191	142	238		
			WIND DIRECTION (deg)					
1.00	265	360	50	85	95	110		
			SOIL TEMPERATURE CHANGE (°C)					
Initial Time	0053	0154	0253	0351	0454	0550		
Run Time (min)	23	22	23	25	21	27		
-.03	-.30	-.28	-.37	-.37	.24	-.01		
-.06	-.20	-.17	-.24	-.31	-.21	-.16		
-.12	-.21	-.14	-.12	-.15	-.13	-.16		
-.25	-.02	-.04	-.03	-.05	-.04	-.05		
-.50	00	.01	00	-.01	00	-.01		
-1.00	00	00	-.01	-.01	00	-.01		
Precipitation (cm)	--	--	--	--	--	--		

Table 8.2 (Continued)

HOURLY OBSERVATIONS	August 8, 1956			O'NEILL, NEBRASKA				
CST	0805	0905	1005	1105	1205	1305		
RADIATION (cal/cm²sec)								
Insolation	.0030	.0139	.0179	.0190	.0220	.0218		
Reflected	--	--	--	--	--	--		
Net Radiation	wet	.0088	.0113	.0110	.0150	.0150		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	18.00	20.84	23.76	25.28	26.74	27.54		
8.00	17.94	21.20	23.79	25.52	27.23	27.76		
4.00	17.96	21.45	24.17	25.80	27.74	28.13		
2.00	17.97	21.93	24.46	26.12	28.01	28.70		
1.00	17.97	22.19	25.09	26.63	28.61	29.70		
.50	17.97	22.62	25.88	27.52	29.64	30.74		
.25	17.96	23.07	26.85	28.33	30.83	31.41		
.12	17.95	23.55	27.68	28.97	31.67	32.71		
-.03	19.30	20.78	24.27	27.44	29.85	31.89		
-.06	20.19	20.56	21.76	24.62	26.71	28.46		
-.12	22.22	22.00	21.04	22.38	23.06	23.93		
-.25	23.18	22.98	22.82	22.75	22.41	22.61		
-.50	21.90	21.88	21.82	21.87	21.87	21.83		
-1.00	20.04	20.02	19.99	20.04	20.06	20.05		
VAPOR PRESSURE (mb)								
16.00	--	14.04	14.74	13.28	12.96	13.16		
8.00	--	14.41	15.05	13.55	13.42	13.83		
4.00	--	14.55	15.26	13.74	13.62	14.03		
2.00	--	14.63	15.35	13.85	13.85	14.18		
1.00	--	14.95	15.58	14.18	14.04	14.40		
.50	-	15.91	15.96	14.66	14.67	14.69		
.25	--	16.13	16.46	15.16	15.17	15.08		
.12	--	16.83	17.16	15.64	15.72	15.61		
WIND SPEED (cm/sec)								
16.00	511	489	368	530	493	531		
8.00	440	466	349	505	487	541		
4.00	385	444	321	473	446	487		
2.00	314	409	298	436	413	452		
1.00	287	385	290	408	391	420		
.50	250	320	245	344	178	--		
.25	212	279	210	317	60	--		
WIND DIRECTION (deg)								
1.00	330	45	5	40	110	150		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	0750	0850	0950	1050	1155	1250		
Run Time (min)	28	27	28	28	21	26		
-.03	.16	1.32	1.68	1.00	.83	.71		
-.06	-.02	.29	.06	1.01	.70	.70		
-.12	-.13	-.09	.06	.26	.34	.34		
-.25	-.07	-.16	-.09	.04	-.55	00		
-.50	-.01	-.03	-.01	.02	-.02	-.03		
-1.00	-.01	-.01	-.02	.03	-.02	-.04		
Precipitation (cm)	--	--	--	--	--	--		

Table 8.2 (Continued)

HOURLY OBSERVATIONS			August 9, 1956			O'NEILL, NEBRASKA		
CST	1405	1505	1605	1705	1805	1905		
RADIATION (cal/cm²sec)								
Insolation	.0200	.0178	.0138	.0082	.0052	.0012		
Reflected	--	.0033	.0029	.0018	.0013	--		
Net Radiation	.0133	.0110	.0077	0041	.0018	-.0011		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	28.02	28.86	28.48	27.91	27.14	25.66		
8.00	28.44	29.37	29.00	28.28	27.35	25.69		
4.00	28.79	29.76	29.60	28.58	27.58	25.67		
2.00	29.28	30.31	30.04	28.90	27.80	25.66		
1.00	29.92	30.69	30.43	29.26	28.03	25.65		
.50	31.31	31.40	30.99	29.65	28.19	25.63		
.25	32.09	32.54	31.77	30.03	28.39	25.62		
.12	33.48	33.55	32.25	30.43	28.68	25.58		
-.03	33.29	34.46	34.46	32.91	30.98	29.02		
-.06	29.97	31.25	31.98	31.63	30.[illegible]8	29.49		
-.12	24.80	25.65	26.43	27.18	27.[illegible]5	27.54		
-.25	22.58	22.74	22.91	23.11	23.[illegible]4	23.71		
-.50	21.79	21.76	21.72	21.69	21.[illegible]	21.76		
-1.00	20.01	19.96	19.94	19.93	20.0[illegible]	20.03		
VAPOR PRESSURE (mb)								
16.00	12.79	13.58	15.40	17.08	17.40	17.51		
8.00	13.46	13.48	15.89	17.31	17.65	17.52		
4.00	13.66	13.57	15.95	17.39	17.73	17.52		
2.00	13.76	13.65	15.95	17.39	17.77	17.51		
1.00	14.04	13.85	16.48	17.43	17.84	17.53		
.50	14.50	14.20	16.49	17.58	17.92	17.57		
.25	14.89	14.47	16.66	17.73	17.86	17.57		
.12	15.58	14.96	16.98	17.80	17.99	17.62		
WIND SPEED (cm/sec)								
16.00	411	295	595	685	744	704		
8.00	396	291	547	624	674	671		
4.00	368	269	508	572	587	601		
2.00	336	256	467	517	515	527		
1.00	317	249	438	483	480	494		
.50	272	218	378	408	418	419		
.25	228	173	318	346	360	351		
WIND DIRECTION (deg)								
1.00	145	140	5	360	350	360		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	1350	1450	1550	1650	1752	1853		
Run Time (min)	26	26	26	26	24	23		
-.03	.52	.12	-.43	-.62	-.72	-.77		
-.06	.60	.37	.06	-.26	-.50	-.51		
-.12	.36	.30	.28	.15	.08	-.03		
-.25	.14	.05	.05	.10	.09	.09		
-.50	-.01	-.03	-.05	-.04	-.01	00		
-1.00	-.01	-.09	-.03	-.02	-.02	.02		
Precipitation (cm)	--	--	--	--	--	--		

Table 8.2 (Continued)

HOURLY OBSERVATIONS			August 8, 1956			O'NEILL, NEBRASKA		
CST	2005	2105	2205	2305	0005*	0105*		
RADIATION (cal/cm²sec)								
Insolation	.0000	--	--	--	--	--		
Reflected	--	--	--	--	--	--		
Net Radiation	-.0015	-.0010	-.0010	-.00085	-.00031	-.00110		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	24.26	23.43	22.45	22.44	21.83	19.68		
8.00	23.38	22.43	21.25	20.15	20.35	18.85		
4.00	22.65	21.15	19.74	18.90	18.86	18.34		
2.00	22.22	19.88	18.81	17.83	17.49	17.86		
1.00	21.82	19.08	17.19	16.46	16.38	17.64		
.50	21.54	18.01	15.91	15.29	15.84	17.41		
.25	21.24	17.23	15.48	14.77	15.62	17.19		
.12	21.02	16.20	15.19	14.34	15.45	17.07		
-.03	27.13	25.30	23.89	22.71	21.96	21.70		
-.06	28.16	26.75	25.56	24.49	23.58	23.09		
-.12	27.34	26.95	26.52	26.00	25.45	25.00		
-.25	23.92	24.07	24.21	24.27	24.25	24.24		
-.50	21.80	21.79	21.80	21.80	21.82	21.88		
-1.00	20.07	20.02	20.03	20.02	20.02	20.04		
VAPOR PRESSURE (mb)								
16.00	18.14	17.63	16.77	15.45	18.65	18.84		
8.00	[illegible]	17.43	15.89	14.64	17.78	18.36		
4.00	18.41	17.49	15.94	14.65	17.78	18.34		
2.00	18.35	17.51	15.98	14.62	17.76	18.28		
1.00	18.35	17.54	16.01	14.68	17.77	18.28		
.50	18.35	17.58	16.01	14.67	17.77	18.34		
.25	18.28	17.58	16.09	15.63	17.71	18.23		
.12	18.20	17.89	16.53	15.06	17.82	18.44		
WIND SPEED (cm/sec)								
16.00	482	296	--	189	118	552		
8.00	343	225	156	179	82	423		
4.00	256	130	114	139	76	338		
2.00	197	85	174	109	85	269		
1.00	157	36	101	66	57	222		
.50	132	19	51	44	50	193		
.25	101	--	--	--	18	151		
WIND DIRECTION (deg)								
1.00	40	--	--	--	--	175		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	1953	2054	2152	2253	2350	0050		
Run Time (min)	23	25	24	23	28	27		
-.03	-.63	-.79	-.50	-.40	-.21	-.23		
-.06	-.52	-.56	-.46	-.40	-.37	-.20		
-.12	-.11	-.17	-.21	-.21	-.26	-.21		
-.25	-.01	.06	.03	00	-.04	-.04		
-.50	.02	.01	00	.03	00	00		
-1.00	.04	.01	-.01	00	-.01	-.01		
Precipitation (cm)	--	--	--	--	--	--		

* August 9, 1956

Table 8.2 (Continued)

HOURLY OBSERVATIONS	August 9, 1956				O'NEILL, NEBRASKA			
CST	0205	0305	0405	0505	0605	0705		
RADIATION (cal/cm^2sec)								
Insolation	--	--	--	.0000	.0011	.0052		
Reflected	--	--	--	.0000	.00035	.0015		
Net Radiation	-.00100	.00099	-.00101	-.00114	-.00038	.0026		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	19.75	19.04	18.36	17.33	16.97	19.12		
8.00	18.69	17.61	16.97	16.01	16.92	19.20		
4.00	17.92	16.97	16.14	16.56	16.70	19.27		
2.00	16.96	16.38	15.46	16.25	16.17	19.34		
1.00	16.08	15.72	14.93	16.02	15.39	19.42		
.50	15.26	15.08	14.47	15.68	14.85	19.53		
.25	14.75	14.81	14.30	15.44	14.98	19.77		
.12	14.39	14.60	14.13	15.22	15.10	19.84		
-.03	21.18	20.22	19.68	19.40	19.00	19.51		
-.06	22.61	21.99	21.38	20.85	20.54	20.37		
-.12	24.56	24.16	23.68	23.28	22.93	22.63		
-.25	24.18	24.10	23.88	23.75	23.70	23.53		
-.50	21.90	21.92	21.9[illegible]	21.92	22.00	21.98		
-1.00	20.03	20.04	20.04	20.04	20.11	20.10		
VAPOR PRESSURE (mb)								
16.00	15.96	15.16	16.45	15.95	17.19	16.07		
8.00	15.25	14.67	15.41	15.70	16.45	17.30		
4.00	15.25	14.67	15.44	15.70	16.48	17.46		
2.00	15.22	14.68	15.39	15.70	16.51	17.49		
1.00	15.23	14.66	15.39	15.70	16.41	17.17		
.50	15.25	14.69	15.41	15.70	16.41	17.20		
.25	15.20	14.68	15.36	15.69	16.21	17.40		
.12	15.91	15.22	15.38	15.97	16.12	17.63		
WIND SPEED (cm/sec)								
16.00	293	404	470	425	147	308		
8.00	278	293	365	336	105	286		
4.00	204	227	288	259	76	263		
2.00	143	160	212	205	106	245		
1.00	96	107	157	160	82	214		
.50	71	88	135	145	62	194		
.25	19	41	98	116	29	161		
WIND DIRECTION (deg)								
1.00	--	--	--	300	160*	230		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	0150	0250	0350	0450	0550	0650		
Run Time (min)	27	27	28	28	26	26		
-.03	-.53	-.19	-.25	-.05	-.18	.64		
-.06	-.24	-.29	-.39	-.16	-.18	.08		
-.12	-.17	-.15	-.20	-.18	-.23	-.16		
-.25	-.03	-.03	-.06	-.06	-.07	-.06		
-.50	.01	+.01	00	.01	-.04	-.05		
-1.00	00	+.01	-.01	.02	00	-.02		
Precipitation (cm)	--	--	--	--	--	--		

*Wind to light to turn vane

Table 8.2 (Continued)

HOURLY OBSERVATIONS · August 9, 1956 · O'NEILL, NEBRASKA

CST	0805	0905	1005	1105	1205	1305		
RADIATION ($cal/cm^2 sec$)								
Insolation	.0071	.0138	.0177	.0204	.0214	.0132		
Reflected	.0015	.00265	.00315	.0035	.0037	.0023		
Net Radiation	.0037	.0077	.0104	.0119	.0127	.0069		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	21.33	23.22	24.75	26.46	27.36	28.05		
8.00	21.66	23.66	25.13	26.75	27.71	28.29		
4.00	21.82	23.92	25.58	27.08	28.14	28.74		
2.00	21.82	24.20	25.90	27.21	28.26	29.24		
1.00	22.04	24.67	26.35	28.03	29.41	29.66		
.50	22.50	25.28	27.44	29.35	30.27	30.38		
.25	22.91	26.47	28.33	30.67	31.52	30.94		
.12	23.54	27.16	29.21	31.68	32.79	32.08		
-.03	20.89	23.10	26.26	29.41	31.98	34.12		
-.06	20.87	21.98	23.82	26.07	28.09	30.21		
-.12	22.33	22.25	22.45	22.96	23.63	24.70		
-.25	23.31	23.11	22.91	22.78	22.68	22.72		
-.50	21.92	21.87	21.83	21.78	21.78	21.74		
-1.00	20.03	19.96	19.99	19.93	19.91	19.95		
VAPOR PRESSURE (mb)								
16.00	22.62	16.91	16.10	14.75	14.37	--		
8.00	27.58	17.36	16.53	15.40	14.79	--		
4.00	27.88	17.50	16.65	15.46	14.86	--		
2.00	27.72	18.82	17.63	15.40	14.78	--		
1.00	26.91	17.63	16.77	15.46	14.85	--		
.50	19.11	17.76	17.08	15.78	15.05	--		
.25	17.29	18.01	17.30	16.09	15.42	--		
.12	17.29	18.34	18.17	16.64	15.98	--		
WIND SPEED (cm/sec)								
16.00	174	338	322	400	393	313		
8.00	176	339	290	373	391	306		
4.00	148	323	273	360	361	286		
2.00	153	300	256	330	332	258		
1.00	136	(273)	239	306	309	235		
.50	128	246	216	276	282	212		
.25	102	204	182	235	239	182		
WIND DIRECTION (deg)								
1.00	265	200	235	230	260	315		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	0750	0850	0950	1050	1148	1251		
Run Time (min)	26	26	26	20	28	26		
-.03	.65	1.10	1.28	1.06	1.17	.22		
-.06	.33	.64	.81	.87	.96	.77		
-.12	-.04	00	.17	.31	.42	.56		
-.25	-.08	.11	.09	-.07	.04	-.01		
-.50	-.01	-.03	-.03	-.06	.07	-.04		
-1.00	00	.12	-.03	-.02	-.02	-.03		
Precipitation (cm)	--	--	--	--	--	--		

Table 8.2 (Continued)

HOURLY OBSERVATIONS			August 9, 1956				O'NEILL, NEBRASKA	
CST	1405	1505	1605	1705	1505*	1605*		
RADIATION (cal/cm²sec)								
Insolation	.0210	.0185	.0080	.0012	.0072	.0125		
Reflected	.0038	.0033	.0016	--	.0013	.0021		
Net Radiation	.0125	.0105	.0030	-.0006	.0038	.0060		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	28.81	29.80	29.27	27.98	32.09	33.00		
8.00	29.29	30.33	29.64	28.07	32.30	33.26		
4.00	29.59	30.88	29.89	28.13	32.59	33.81		
2.00	30.01	30.80	30.11	28.13	32.94	34.32		
1.00	30.27	31.06	30.24	28.18	33.30	34.84		
.50	31.03	32.88	30.75	28.18	33.62	35.61		
.25	33.04	33.92	31.27	28.18	34.00	36.10		
.12	34.02	34.94	32.12	28.15	34.35	36.50		
-.03	35.64	36.77	36.01	33.28	30.82	32.05		
-.06	31.53	32.79	33.30	32.44	28.54	28.86		
-.12	25.77	26.64	27.48	27.98	25.65	25.70		
-.25	22.76	22.88	23.06	23.31	23.10	23.30		
-.50	21.69	21.65	21.60	21.56	21.39	21.51		
-1.00	19.91	19.87	19.82	19.84	19.62	19.47		
VAPOR PRESSURE (mb)								
16.00	13.06	13.60	13.53	14.38	12.71	13.24		
8.00	13.85	14.06	13.85	14.55	12.90	13.48		
4.00	13.95	14.17	13.89	14.60	12.94	13.53		
2.00	13.92	14.16	13.94	14.65	13.00	13.64		
1.00	14.04	14.26	14.09	14.66	13.09	13.68		
.50	14.32	14.59	14.27	14.74	13.13	13.71		
.25	14.64	14.66	14.51	14.76	13.18	13.77		
.12	15.05	14.87	14.88	14.85	13.23	13.82		
WIND SPEED (cm/sec)								
16.00	246	277	154	573	753	889		
8.00	261	279	153	501	727	843		
4.00	244	261	141	463	664	764		
2.00	230	244	144	416	590	678		
1.00	217	228	133	370	522	603		
.50	200	205	125	325	456	527		
.25	166	175	101	276	383	440		
WIND DIRECTION (deg)								
1.00	215	250	85	30	158	162		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	1353	1454	1553	1653	1453	1653		
Run Time (min)	25	24	25	23	24	23		
-.03	.60	.32	-.56	-1.23	-.03	-.46		
-.06	.56	.46	.17	-.50	.16	-.34		
-.12	.39	.38	.33	.18	.08	.10		
-.25	.03	.05	.11	.10	.03	.05		
-.50	-.03	00	00	-.01	00	00		
-1.00	-.01	-.04	.01	.01	.02	-.02		
Precipitation (cm)	--	--	--	--	--	--	* August 27, 1956	

Table 8.2 (Continued)

HOURLY OBSERVATIONS			August 27, 1956			O'NEILL, NEBRASKA		
CST	1705	1905	2105	2205	0005*	0105*		
RADIATION (cal/cm²sec)								
Insolation	.0070	.0003	.0000	.0000	.0000	.0000		
Reflected	.0014	--	.0000	.0000	.0000	.0000		
Net Radiation	.0027	-.0011	-.0010	-.0008	-.0006	-.0009		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	33.22	31.13	29.11	26.72	24.46	21.75		
8.00	33.32	30.55	26.72	24.90	21.38	20.03		
4.00	33.60	29.67	24.95	22.57	20.11	19.02		
2.00	33.95	28.94	22.59	20.69	18.83	18.37		
1.00	34.34	27.41	18.84	19.72	18.29	17.65		
.50	34.64	25.57	17.45	19.02	17.68	16.78		
.25	35.04	24.45	16.86	18.56	17.26	16.47		
.12	35.36	23.85	16.28	18.09	16.94	16.06		
-.03	32.19	29.07	25.04	23.77	22.52	21.79		
-.06	29.40	28.58	26.26	25.04	23.67	23.14		
-.12	25.91	26.36	26.26	25.76	24.96	24.57		
-.25	23.38	23.65	23.98	23.96	23.99	23.92		
-.50	21.49	21.54	21.60	21.58	21.61	21.62		
-1.00	19.44	19.56	19.77	19.78	19.78	19.76		
VAPOR PRESSURE (mb)								
16.00	13.55	14.87	14.32	--	14.48	14.49		
8.00	13.70	15.00	18.10	--	15.20	14.84		
4.00	13.73	14.80	15.76	--	15.06	14.85		
2.00	13.76	14 88	15.55	--	14.82	14.77		
1.00	13.81	14.75	14.35	--	14.70	14.51		
.50	13.87	14.45	14.08	--	14.38	14.51		
.25	13.93	14.22	13.89	--	14.37	14.53		
.12	13.98	14.05	13.73	--	14.32	14.48		
WIND SPEED (cm/sec)								
16.00	825	230	213	320	167	337		
8.00	784	201	157	325	138	265		
4.00	706	163	136	262	103	206		
2.00	625	147	149	165	100	169		
1.00	555	83	70	76	66	113		
.50	490	49	33	59	70	99		
.25	403	--	--	30	52	74		
WIND DIRECTION (deg)								
1.00	165	--	--	--	--	--		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	1652	1850	2050	2150	0000	0050		
Run Time (min)	24	27	27	27	26	25		
-.03	-.25	-.96	-.69	-.30	-.27	- 37		
-.06	.09	-.40	-.55	-.38	-.27	-.28		
-.12	.12	.02	-.14	-.15	-.18	-.14		
-.25	.03	.06	-.03	.04	.00	-.02		
-.50	-.02	.02	.01	.02	.02	.00		
-1.00	-.01	.01	.00	.02	.00	00		
Precipitation (cm)	--	--	--	--	--	--		

* August 28, 1956

Table 8.2 (Continued)

HOURLY OBSERVATIONS			August 28, 1956			O'NEILL, NEBRASKA		
CST	0205	0305	0405	0505	0605	0705		
RADIATION (cal/cm²sec)								
Insolation	.0000	.0000	.0000	.0000	.0004	.0045		
Reflected	.0000	.0000	.0000	.0000	.0001	.0011		
Net Radiation	.0009	-.0004	-.0006	-.0008	-.0007	.0021		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	23.14	21.93	22.32	21.28	19.15	19.74		
8.00	21.83	21.04	21.37	20.04	17.71	19.95		
4.00	20.87	19.90	20.27	18.55	16.50	20.15		
2.00	19.97	18.95	19.01	17.39	15.65	20.28		
1.00	19.30	18.45	16.91	15.97	14.93	20.51		
.50	18.59	17.98	14.59	15.13	13.72	20.84		
.25	18.10	17.65	13.92	14.75	13.30	21.14		
.12	17.76	17.47	13.38	14.43	13.02	21.41		
-.03	21.23	20.87	20.63	19.91	19.42	19.60		
-.06	22.63	22.15	21.88	21.41	20.94	20.63		
-.12	24.27	23.93	23.60	23.30	22.99	22.70		
-.25	23.91	23.83	23.73	23.61	23.50	23.38		
-.50	21.68	21.71	21.73	21.73	21.74	21.74		
-1.00	19.82	19.83	19.83	19.83	19.83	19.85		
VAPOR PRESSURE (mb)								
16.00	14.82	14.57	14.99	14.70	14.87	14.80		
8.00	15.04	14.70	14.78	14.90	13.83	14.87		
4.00	14.87	15.05	14.78	14.70	13.80	14.87		
2.00	14.69	15.05	14.69	14.68	13.58	14.85		
1.00	14.52	14.95	14.51	14.59	13.02	14.86		
.50	14.50	14.93	14.13	14.43	12.92	14.90		
.25	14.39	14.85	13.82	14.39	12.85	14.87		
.12	14.31	14.83	13.68	14.37	12.80	14.97		
WIND SPEED (cm/sec)								
16.00	289	99	314	422	223	400		
8.00	248	149	183	365	184	393		
4.00	192	144	112	301	99	366		
2.00	158	114	111	236	57	326		
1.00	106	61	81	164	41	290		
.50	90	51	32	124	46	256		
.25	64	36	--	97	31	205		
WIND DIRECTION (deg)								
1.00	--	--	--	--	340	151		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	0150	0250	0350	0450	0550	0650		
Run Time (min)	26	26	26	26	27	26		
-.03	-.18	.07	-.35	-.27	-.22	.03		
-.06	-.21	-.16	-.13	-.16	-.18	00		
-.12	-.12	-.15	-.12	-.11	-.10	-.12		
-.25	-.02	-.02	-.03	-.07	-.08	-.08		
-.50	.03	00	.01	00	00	-.01		
-1.00	.01	.01	00	00	00	00		
Precipitation (cm)	--	--	--	--	--	--		

Table 8.2 (Continued)

HOURLY OBSERVATIONS			August 28, 1956				O'NEILL, NEBRASKA	
CST	0805	0905	1005	1105	1205	1305		
RADIATION (cal/cm²sec)								
Insolation	.0070	.0125	.0155	.0195	.0165	.0185		
Reflected	.0015	.0022	.0024	.0031	.0028	.0016		
Net Radiation	.0035	.0061	.0085	.0115	.0100	.0030		
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	20.96	24.98	26.94	30.36	31.11	31.34		
8.00	21.09	25.34	27.25	30.86	31.51	31.71		
4.00	21.20	25.62	27.69	31.39	31.86	31.91		
2.00	21.29	26.02	28.07	32.26	32.43	32.27		
1.00	21.59	26.26	28.87	32.90	33.36	32.56		
.50	22.04	26.78	29.63	33.63	33.97	33.41		
.25	22.05	27.74	30.77	34.42	34.99	34.28		
.12	23.20	28.51	31.45	34.98	35.90	34.98		
-.03	21.41	24.46	27.96	31.28	33.95	35.24		
-.06	21.14	22.41	24.44	26.63	28.62	30.25		
-.12	22.40	22.34	22.52	22.95	23.76	24.61		
-.25	23.20	23.02	22.85	22.68	22.70	22.70		
-.50	21 73	21.70	21.68	21.58	21.64	21.61		
-1.00	19.82	19.83	19 80	19.74	19.84	19.82		
VAPOR PRESSURE (mb)								
16.00	15.80	17 96	17.19	13.44	14.76	12.31		
8.00	15.92	[illegible]	17.58	14.32	15.05	12.57		
4.00	16.00	[illegible]	17.60	14.37	15.05	12.57		
2.00	16.04	18.06	17 63	14.30	15.03	12.58		
1.00	16.10	18.09	17.65	14.21	15.08	12.59		
.50	16.20	18.18	17 72	14.48	15.11	12.66		
.25	16.43	18.36	17.80	14.63	15.16	12.71		
.12	16.51	18.54	17.88	14.78	15.19	12 86		
WIND SPEED (cm/sec)								
16.00	159	185	331	546	637	464		
8.00	162	194	322	488	598	456		
4.00	148	183	307	475	553	433		
2.00	144	171	281	428	476	384		
1.00	114	137	253	385	438	339		
.50	117	135	235	348	403	307		
.25	94	117	207	303	367	269		
WIND DIRECTION (deg)								
1.00	315	45	315	360	360	315		
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	0750	0850	0950	1050	1150	1250		
Run Time (min)	[illegible]	26	26	26	27	27		
-.03	.67	1.50	1.43	1.17	.74	.19		
-.06	.32	.76	.87	.88	.83	.66		
-.12	[illegible]	.04	.16	.22	.38	.42		
-.25	-.08	-.05	-.08	-.08	-.01	.01		
-.50	-.01	-.01	00	-.04	00	-.02		
-1.00	00	.01	00	00	-.01	-.04		
Precipitation (cm)	--	--	--	--	--	--		

Table 8.2 (Continued)

HOURLY OBSERVATIONS	August 28, 1956							O'NEILL, NEBRASKA
CST	1405	1505	1805					
RADIATION (cal/cm²sec)								
Insolation	.0175	.0157	--					
Reflected	.0029	.0027	--					
Net Radiation	.0097	.0083	--					
AIR and SOIL TEMPERATURES (°C)								
Height (m)								
16.00	31.87	29.63	32.96					
8.00	32.20	30.26	33.08					
4.00	33.01	30.67	33.16					
2.00	33.54	31.38	33.18					
1.00	34.01	32.23	33.22					
.50	34.80	32.94	33.26					
.25	36.16	33.84	33.28					
.12	37.14	34.52	33.32					
-.03	35.59	36.25	31.00					
-.06	31.11	31.98	29.25					
-.12	25.44	26.14	26.24					
-.25	22.76	22.93	23.53					
-.50	21.60	21.59	21.52					
-1.00	19.83	19.84	19.52					
VAPOR PRESSURE (mb)								
16.00	13.80	17.16	13.92					
8.00	14.05	17.28	14.09					
4.00	14.07	17.28	14.11					
2.00	14.07	17.27	14.12					
1.00	14.08	17.29	14.20					
.50	14.17	17.31	14.23					
.25	14.24	17.30	14.30					
.12	14.39	17.31	14.32					
WIND SPEED (cm/sec)								
16.00	746	954	567					
8.00	790	946	511					
4.00	744	893	466					
2.00	669	798	407					
1.00	593	711	356					
.50	532	626	315					
.25	451	542	261					
WIND DIRECTION (deg)								
1.00	288	295	--					
SOIL TEMPERATURE CHANGE (°C)								
Initial Time	1350	1450	1750					
Run Time (min)	27	28	27					
-.03	.72	-.06	-.57					
-.06	.36	.23	.08					
-.12	.33	.31	.10					
-.25	.06	.06	.04					
-.50	.01	.02	00					
-1.00	00	-.03	.01					
Precipitation (cm)	--	--	--					

Table 8.3 Soil moisture and soil density, O'Neill, Nebraska, 1956

Date:	July 10		July 16	
Depth (cm)	Soil Moisture (% Dry Wt.)	Soil Density (Gr/cm^3)	Soil Moisture (% Dry Wt.)	Soil Density (Gr/cm^3)
0-10	7.2	1.06	6.8	.99
10-20	7.0	1.13	6.3	1.07
20-30	3.8	1.28	6.3	1.11
30-40	4.2	1.35	4.9	1.17
40-50	5.1	1.31	3.9	1.19
50-60	3.1	1.43	3.7	1.20
60-70	1.9	1.53*	3.4	1.27
70-80	1.8	1.53*	3.2	1.29
80-90	2.9	1.53*	4.8	1.40
90-100	5.7	1.53*	4.8	1.45
Date:	**August 6**		**August 29**	
Depth (cm)	**Soil Moisture (% Dry Wt.)**	**Soil Density (Gr/cm^3)**	**Soil Moisture (% Dry Wt.)**	**Soil Density (Gr/cm^3)**
0-10	9.2	1.03	6.6	1.05
10-20	6.6	1.11	6.5	1.19
20-30	3.0	1.23	6.0	1.22
30-40	2.8	1.27	4.4	1.35
40-50	2.9	1.29	5.6	1.29
50-60	3.5	1.32	6.7	1.39
60-70	6.2	1.20	3.8	1.51
70-80	3.8	1.35	2.9	1.56
80-90	2.6	1.45	2.4	1.58
90-100	1.8	1.60	2.4	1.68

*Mean value, 60-100cm.

CHAPTER 9

EVALUATION OF THE FLUXES OF SENSIBLE AND LATENT HEAT FROM MEASUREMENTS OF WIND, TEMPERATURE, AND DEW POINT PROFILES

M. H. Halstead* and W. H. Clayton
Texas A&M Research Foundation

9.1 Introduction

Inasmuch as the macroparameters of meteorology are, in many cases, determinable by the microparameters in the near surface layers of the atmosphere, a great deal of study has been conducted by many investigators towards better evaluation of these microparameters. A basic attack on the problem lies in the determination of the surface energy budget; and it is the purpose of this paper to present a method of evaluating the various terms of the energy balance relationship from measurements of moisture, net radiation, and the vertical gradients of wind, temperature, and moisture at a particular site for a given time interval.

From conservation of energy requirements, the sum of energy fluxes entering or leaving the earth's surface must be zero. Or

$$R_n + q_c + q_e + q_s = 0 \tag{1}$$

where R_n = net radiative flux of heat,

q_c = flux of sensible heat to the air,

q_e = flux of latent heat from evaporation or condensation of water, and

q_s = conductive heat flux into or out of the ground.

The net radiation is easily measurable directly and need not concern us here other than as a measure of the reliability of the other terms in Eq. (1).

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Measurements of soil heat flux, though not performed directly, are based on the Fourier conduction equation and the treatment shown in this paper is no different from that of previous authors (for example, Sutton[5]).

The essential difference between this and previous papers is based on a definition of turbulent flow first advanced by Halstead.[2] This, in turn, leads to evaluations of q_c and q_e in a turbulent regime different from those obtained through the classical concept of equivalence of exchange coefficients for heat and momentum.

The applicability of these evaluations is shown by heat budget computations based on data collected during Project Prairie Grass by personnel of Texas A&M Research Foundation.

9.2 The Flux of Momentum

The transfer rate of molecular momentum within a gas per unit time and area, in a direction perpendicular to the mean velocity of the gas (or tangential shear), is proportional to the vertical gradient of the velocity. That is,

$$\tau_z = \mu du/dz \tag{2}$$

where μ is defined as the absolute viscosity of the gas. Equation (2), though first presented as an empirical concept, can easily be derived from kinetic theory.

This derivation shows that

$$\mu = \rho \bar{c} L/3 \tag{3}$$

where $\bar{c}$ is the root-mean-square velocity of the molecules comprising the gas, ρ is the density, and L is the mean free path. If the scale of motion within the gas, as characterized by the product uz, where z is the distance from the bounding surface, exceeds the molecular scale of motion as shown by $\bar{c}L$, by a sufficient amount, the flow ceases to be laminar and becomes irregular or chaotic or, as usually described, turbulent.

The critical values of this ratio for tubes of various sizes were first investigated by Reynolds, who found that turbulent motion occurred

in a tube of diameter d when

$$R_e = 3ud/\bar{c}L = \rho\, ud/\mu > 2000. \tag{4}$$

Even though turbulent motion is present, a laminar sublayer adjacent to the boundary can still exist. The thickness of this layer is determinable from R_e for flow over smooth surfaces. Assuming a linear profile within the laminar layer, the surface friction 1 is

$$\tau_0 = .332\,\rho\, u_\delta^2 / \sqrt{R_e} .$$

From integration of Eq. (2), assuming $\tau \neq \tau(z)$,

$$\tau_0 = \rho\, \bar{c} L\, u_\delta / 3\delta .$$

Thus, the localized Reynolds' number is

$$R_c = 3\, u_\delta\, \delta / \bar{c} L = 135 . \tag{5}$$

It should be noted that the flow pattern at $z = \delta$ will not be strictly laminar or turbulent. That is, $z = \delta$ cannot be interpreted as a point but rather as a region. However, for purposes of discussion here, δ will be regarded as the thickness of the laminar layer.

To apply Eq. (2) to a turbulent regime, the molecular viscosity must be replaced by a term, usually referred to as the eddy viscosity, which will be a function of the distance from the bounding surface.

Inasmuch as division between laminar and turbulent flow does not occur at a precise point, it appears reasonable that the eddy viscosity should be so defined that it reduces to the molecular viscosity. That is, Eq. (2) could be written as

$$\tau_z = K\, du/dz , \tag{6}$$

where K will be equal to μ at $z = \delta$.

Consider a flow of gas over a smooth surface and assume n hypothetical surfaces inserted in the gas above the boundary, each a mean distance δ units above the layer preceding it. That is, the first

surface is coincident with the top of the laminar sublayer. The effect of turbulence may be thought of as a factor of area distortion of a given surface. Hence, the area of the surface at elevation j will be greater than the area of the surface at j - δ and less than the surface at elevation j + δ. This is shown in Figure 9.1.

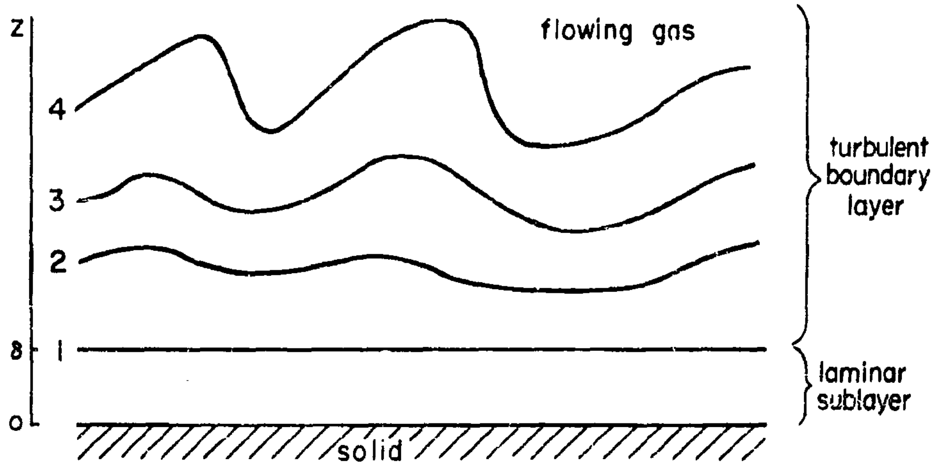

Figure 9.1 Distorted Area Pattern

The first surface has the same area as the smooth boundary itself inasmuch as below $z = \delta$ the flow is laminar. Above $z = \delta$, a given surface becomes distorted due to the distortion of the preceding surface, plus any inherent distortion of the surface itself.

Let r be the ratio of areas of any two adjacent surfaces. Then

$$r = A_n/A_{n-1}.$$

Hence, Eq. (6) may be written $\tau_z = \mu A_n/A_o \ du/dz.$ (7)

Thus, the area of the nth layer at elevation z will be

$$A_n = A_1 \, rn.$$

Since $A_1 = A_o$,

$$A_n/A_o = r\,z/\delta\,. \tag{8}$$

Substituting Eq. (8) in Eq. (7), we obtain,

$$\tau_z = rz\,\mu/\delta \;\; du/dz\,, \tag{9}$$

as applicable to turbulent flow.

The shearing stress τ_z will vary with elevation, being a maximum at $z = 0$, and decreasing with elevation. For the atmosphere, τ_z will vanish at $z = H$, where H is the geostrophic wind level.

Assuming a linear variation of shearing stress with height*, we **may write,**

$$\tau_z = \tau\,(1-z/H)\,, \tag{10}$$

where τ is the stress at the top of the laminar layer, which for all practical considerations for the atmosphere will equal the shear stress at the surface. Hence,

$$\tau_o(1-z/H) = \rho\,\bar{c}\,(Lrz/3\,\delta)\;du/dz \tag{11}$$

Actually, ρ and $\bar{c}$ and L will vary with height also, but for the lower layers of the atmosphere this variation will be small.

Separating variables and integrating from δ to z, we obtain,

$$u_z = u_\delta + 3\delta\tau_o(\ln z/\delta - z/H)/\rho\,\bar{c}Lr \tag{12}$$

From integration of Eq. (7) from $z = 0$ to $z = \delta$ ($\tau_o = \tau_z$, $K = \mu$),

$$u_\delta = 3\tau_o\delta/\rho\,\bar{c}L\,. \tag{13}$$

*This is equivalent to assuming a unidirectional mean velocity, negligible Coriolis acceleration, and a uniform horizontal pressure gradient.

Thus,

$$u_z = u_\delta [1 + (\ln z/\delta - z/H)/r] . \tag{14}$$

Inasmuch as the discussion is restricted to the region where z is of the order of a few meters, while H will be of the order of 500 meters, z/H of Eq. (14) will be insignificant with respect to $\ln z/\delta$ and the former term may be neglected. Thus,

$$u_z = u_\delta [1 + (\ln z/\delta) r] . \tag{15}$$

Equation (15) is analogous to the wind profile equation derived from mixing length concepts, that is,

$$u_z = u_* [A + (\ln u_* z/\nu)/k] \tag{16}$$

where $u_* = \sqrt{\tau/\rho}$, k is von Karman's constant ($k = 0.40$), and A is a constant. It is interesting to convert Eqs. (15) and (16) to identical form, inasmuch as A and k have been evaluated from empirical studies.

From Eqs. (5) and (13),

$$u_\delta = R_c \nu/\delta = u_*^2 \delta/\nu . \tag{17}$$

Substituting in Eq. (15)

$$u_z = u_* [A + (\ln z u_*/\delta) k] \tag{18}$$

which is identical to Eq. (16) when

$$A = u_* \delta/\nu [1 - (\ln u_* \delta/\nu)/r] \tag{19}$$

and

$$k = \nu r/u_* \delta . \tag{20}$$

Using Nikuradse's (Sutton[5]) data for flow near a smooth surface, $A = 5.5$ for $k = .40$; hence, $r = 4.65$.

More recent work by Laufer at the Bureau of Standards affirms the Nikuradse data and leads to the same r value.

Substituting this value in Eq. (15),

$$u_z = u_\delta[\,1 + (\ln z/\delta)/4.65\,]\,,\; z > \delta \tag{21}$$

for flow near a smooth bounding surface.

Within the laminar sublayer ($z \leq \delta$), u is given from Eq. (17) and using $\mu = 1.8 \times 10^{-4}$ gm/cm sec, $\rho = 1.2 \times 10^{-3}$ gm/cm^3,

$$u_\delta = 20.3/\delta\,. \tag{22}$$

Figure 9.2 shows Eqs. (21) and (13) for several τ values, plotted as velocity versus the logarithm of elevation. The turbulent and laminar regimes are separated by the line along which $u_\delta\,\delta = 20.3$.

The applicability of Eq. (21) is limited to small elevations and smooth surfaces. We can rigorously define elevation but not a smooth surface. Aerodynamically speaking, a smooth surface means a surface that does not physically protrude through the laminar sublayer. However, since the thickness of this layer depends upon the velocity, a surface consisting of No. 4 sandpaper could be a smooth surface; and, under other flow conditions, a pane of glass could be a rough surface.

While a satisfactory theoretical treatment of the effect of surface roughness has yet to be developed, it is reasonable to think of the roughness elements as sinks of momentum which in total are equivalent to a "drag velocity." Hence, for the postulated type of flow over a rough surface, Eq. (21) can be modified to

$$u_z = u_\delta[\,1 + (\ln z/\delta)/4.65\,] - u_s\,, \tag{23}$$

where u_s is the drag velocity corresponding to momentum transferred to surface roughness elements, assuming no modification of the roughness elements by the flow. Further, the length δ must then represent, not the thickness of an actual sublayer, but more generally, the thickness of any layer which would give a distortion r. Since it is impossible to determine the sink strength of a surface theoretically or to

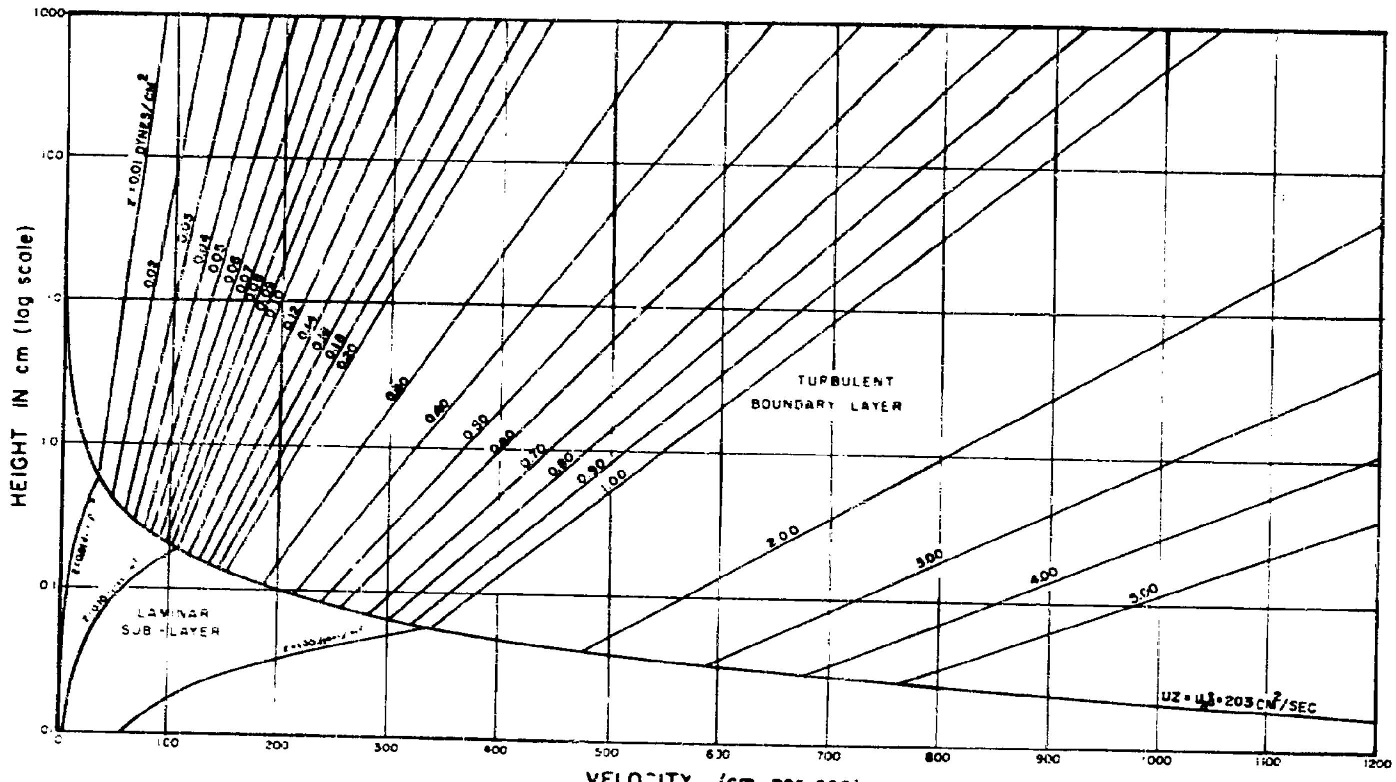

Figure 9.2 Wind profile grid for steady flow of air at constant temperature over aerodynamically smooth surfaces

measure u_s directly, it is necessary to eliminate the "drag velocity" by solving Eq. (23) simultaneously for more than one level.

In the presence of a vertical gradient of potential temperature, the modification of the flow pattern can be significant, as the density, mean free path, and root mean square velocity of the gas will change with elevation. That is, a buoyancy term will be present. This will be true in the laminar as well as in the turbulent region. For the lower layers of the atmosphere to which this discussion is restricted, the effects of buoyancy can be large, varying velocities and transfer rates through one or two orders of magnitudes. Fortunately, however, these effects do not appreciably influence the logarithmic nature of the profiles in the layers below one or two meters, hence need not be considered. Actually, this requires that z be no greater than the elevation for which u vs ln z is linear.

In general, the argument presented implies that turbulent transfer is not a function of an exchange coefficient varying with lateral or vertical displacement but a rate of distortion of laminar flow area which will vary from case to case, but will remain constant for a given flow pattern.

In order to apply the development to measurements of momentum transfer to the surface, we require the difference in velocity between a height z and 2z. From Eq. (23)

$$u_{2z} - u_z = (u_\delta \ln 2)/r . \qquad (24)$$

Substituting Eq. (23) in (13) and recalling that r = 4.65, then the total momentum flux at the surface (or any elevation, z, since Eq. (23) is essentially based on constancy of shearing stress with height) is given by

$$\tau_z = 1/3\rho\,(u_{2z} - u_z)^2 . \qquad (25)$$

Inasmuch as this equation will be used again in the evaluation of the convective and evaporative fluxes of heat, it will be worthwhile to repeat the meaning of the various terms entering this equation.

These are listed below:

u_z = mean wind speed at elevation z,

u_δ = mean speed at the top of the laminar sublayer (fictional for flow over a rough surface),

r = 4.65, increase in surface area due to turbulent distortion of a single layer of mean thickness δ,

δ = thickness of layer producing a constant distortion r (for flow over smooth surfaces, the thickness of the laminar sublayer).

9.3 The Flux of Sensible Heat

The rate of vertical transfer of heat (q_c) per unit time and unit area within a gas is proportional to the density of the medium, the specific heat, and the gradient of potential temperature, or for non-turbulent flow,

$$q_c = \nu_c \rho c_p \, dT/dz \, , \tag{26}$$

where ρ is density, c_p is the specific heat at constant pressure, T is potential temperature, and ν_c is a constant of proportionality related to the product of molecular mean free path and root-mean-square velocity, and generally referred to as the thermal diffusivity. It has the same units as kinematic viscosity, cm^2/sec in the cgs system.

If air is in turbulent motion, transfer of heat is still expressible by Eq. (26) but with a dependency on the scale of motion within the fluid. That is, heat is transferred by parcels of air as well as by individual molecules.

As in the case of flux of momentum, consider a flow of air over a smooth boundary with hypothetical, equally spaced surfaces separating layers of the moving air. For laminar flow, each surface will be parallel to every other surface, or each surface will have the same area. For turbulent flow, however, each surface will have a different area depending on the degree of turbulence. The first of this hypothetical group of surfaces will be parallel to the solid surface itself, if it is located at the top of the laminar layer, which is at a distance δ

above the solid boundary. Surface number two, at a mean distance δ above number one, will be distorted to a degree depending on the scale of motion between the two surfaces. Surface number three (at a mean distance δ above surface two) will be distorted according to the scale of motion between it and surface one, or between it and number two, plus the distortion between surfaces one and two.

The area of a surface at a given height, z, is a measure of the opportunity for energy transfer. This area A_n, divided by the area of surface number one (or the area of the boundary itself, A_0), will be equal to rn where r is the fractional increase in area due to turbulent distortion and n is the number of surfaces, each a mean distance δ apart, between the boundary and elevation z.

Thus,

$$A_n = A_0 rz/\delta . \tag{27}$$

Hence, Eq. (26) may be written as

$$q_c = K_c \rho c_p dT/dz , \tag{28}$$

where $K_c = \nu_c$ for $z \leq \delta$ (laminar flow),

and for turbulent flow (over smooth surfaces) as,

$$q = \nu_c rz \rho c_p/\delta \, dT/dz . \tag{29}$$

Restricting the application of Eq. (29) to small values of z, constancy of ν_c, ρ, and c_p may be assumed. This, in effect, means negligibility of any buoyancy terms.

For the same conditions given in the preceding section for stress varying linearly with elevation, we assume a linear variation of q with elevation, or

$$q_c = q_0 (1 - z/H) , \tag{30}$$

where H is the thickness of the turbulent layer, or geostrophic wind level.

Substituting Eq. (30) in (29), separating variables, and integrating from the top of the laminar layer to an elevation z,

$$T_z = T_\delta[1 + (\ln z/\delta - z/H)/r], \tag{31}$$

where

$$T_\delta = q_c\delta/\rho\, c_p\, \nu_c. \tag{32}$$

For small values of z, the term z/H will be negligible in comparison with $\ln z/\delta$ and may be omitted. Thus,

$$T_z = T_\delta\,[1 + (\ln z/\delta)/r], \tag{33}$$

for flow over smooth surfaces.

For flow over aerodynamically rough surfaces, we parallel the previous view concerning momentum. That is, we will regard roughness elements to act as sources or sinks of heat, according to the temperature differences between the elements and the ambient, and postulate a potential temperature equivalent to the magnitude of the sources or sinks. In this view, Eq. (32) may be modified to

$$T_z = T_\delta[1 + (\ln z/\delta)/r] + T_s. \tag{34}$$

Generally, T_s will be unknown, but it is not involved when Eq. (34) is applied to potential difference between two levels. For the particular levels z and 2z,

$$T_{2z} - T_z = T_\delta\,(\ln 2)/r. \tag{35}$$

Combining Eqs. (17), (24), (32), and (35), we obtain

$$q_c = c_p r^2\, \rho\, \nu_c\,(T_{2z} - T_z)\,(u_{2z} - u_z)/R_c\, \nu\, (\ln 2)^2, \tag{36}$$

for evaluation of the flux of sensible heat.

Using the values

$$\rho = 1.2 \times 10^{-3}\ \text{gm/cm}^3,$$

$$c_p = 0.24\ \text{cal/gm deg C},$$

$$\nu_c = 0.21\ \text{cm}^2/\text{sec},$$

$$\nu = 0.15\ \text{cm}^2/\text{sec},$$

$$r = 4.65, \text{ and}$$

$$R_c = 135,$$

in Eq. (36)

$$q_c = .124 \times 10^{-3} (u_{2z} - u_z)(T_{2z} - T_z) \tag{37}$$

with q_c in cal/cm^2 sec, velocity in cm/sec, and temperature in degrees Centigrade.

9.4 The Flux of Water Vapor

Evaporation of a fluid is a measure of the difference of exchange rates of molecules of the fluid between the surface and the surrounding medium. For the case in which molecules escaping from the surface of the fluid are influenced only by their concentration and the molecular properties of the surrounding medium (for example, still air over water), the evaporation is given by,

$$E = \sigma\, d\rho'/dz, \tag{38}$$

where σ is the diffusion coefficient, and ρ' is the density of the fluid vapor. While σ will vary slightly with temperature, it may be considered constant for purposes of this discussion. Its value for 15°C is .250 cm^2/sec.

If the air is in turbulent motion, Eq. (38) requires modification to allow for non-molecular transfer. As in the previous cases of transfer of momentum and heat, we will generalize the laminar flow

case to include turbulent flow by introducing a factor to allow for the increased area of contact between the turbulently distorted layers, or

$$E = \sigma r\, z/\delta\, d\rho'/dz\,. \tag{39}$$

Using the same reasoning that has been applied for the wind and temperature profiles with respect to variations in E with height, surface roughness, and thermal buoyancy, the evaporation is given as

$$E = \sigma(u_{2z} - u_z)(\rho'_{2z} - \rho'_z)/3\,, \tag{40}$$

where E will be given in gm/cm^2 sec for ρ' in gm/cm^3, and u in cm/sec.

In order to compute the flux of latent heat by evaporation, Eq. (40) must be multiplied by the latent heat of vaporization of water for the particular temperature concerned. Using 20°C as an average temperature and converting absolute humidity to an equivalent vapor pressure by use of

$$\rho' = eM/RT \tag{41}$$

where

M = 18, molecular weight of water,

R = 8.31×10^{-7} erg deg, universal gas constant,

T = 293°K,

e = vapor pressure (millibars), and

q_e = evaporative flux of heat,

we can write approximately,

$$q_e \approx .240 \times 10^{-3}(u_{2z} - u_z)(e_{2z} - e_z)\,, \tag{42}$$

when q_e is given in cal/cm^2 sec.

9.5 Soil Heat Flux

Inasmuch as transfer of heat energy within the soil is by conduction, the equation for heat flux in the soil is given by the Fourier relation,

$$\partial T/\partial t = \nu_c \nabla^2 T \tag{43}$$

where T = temperature, and ν_c = thermal diffusion coefficient. If $\partial^2 T/\partial x^2 = \partial^2 T/\partial y^2 = 0$, using Eq. (26) to define the heat flux, and considering z to increase positively with height,

$$q_o = q_z + \int_z^o \rho c_p (\partial T/\partial t) dz. \tag{44}$$

Since it is desirable to determine the surface heat flux from soil temperature difference with time, q_z must equal zero. That is, measurements must cover the range from the surface to a point where $\partial T/\partial z = 0$. Hence,

$$q_o = \int_z^o \rho c_p (\partial T/\partial t) dz. \tag{45}$$

9.6 Computation of Surface Heat Budgets

During the 70 gas releases of Project Prairie Grass, personnel of the Texas A&M Research Foundation made measurements of net radiation as well as of wind velocity, vapor pressure, air temperature, and soil temperature at several levels. These data have been used in the energy balance equation as a measure of the applicability of the expressions developed for evaluating the fluxes of sensible and evaporative heat.

The systems of measurement employed in the study are described in Chapter 7 of this report and need not be repeated here. The method of analysis of the data as pertinent to the various flux computations, however, is given below.

Referring to Eq. (37), evaluation of $\Delta u = (u_{2z} - u_z)$ and $\Delta T = (T_{2z} - T_z)$

is all that is required to evaluate the flux of sensible heat. These values, of course, are obtainable from profile measurements of wind speed and air temperature. Specifically, the mean values of u and T at 12.5, 25, 50, 100, 200, 400, 800, and 1600 centimeters were measured for a 20- to 30-minute interval surrounding the gas release intervals and plotted versus the logarithm of elevation. Inasmuch as the developed relationships apply in the region where u is linear with ln z, the portions of the profiles significant to the study are straight lines, and the double-level variation is merely the abscissa increment between any two successive levels along the profile.

To minimize plotting and reading errors, the increments were read between four levels and divided accordingly. Of course, not all profiles were strictly linear. In such cases the "best sight" fit to a linear profile was used with greatest weight given to the lowest levels where deviation from linearity was a minimum.

In the u evaluation, extrapolation of the profile to $u = 0$ gives the roughness parameter z_o, as can be seen from

$$u = (u_* \ln z/z_o)/k, \tag{46}$$

which is another form of Eq. (16). A value of 0.6 cm was found to be the z_o value for the measuring station location. This value represents the average value of the ln z versus u intercepts of 16 profiles that were essentially linear at all levels. Hence, all wind profiles were drawn as straight lines from the point $z = 0.6$ cm, $u = 0$, through the lower four points of u versus the logarithm of z.

The increment of vapor pressure $\Delta e = (e_{2z} - e_z)$ was obtained similarly from measurements of vapor pressure at the same elevations used for wind speed and air temperature.

The soil heat flux at the surface is given by Eq. (45). Both ρ and c_p vary with depth but so slightly, for the interval considered, that they may be treated as constant. For the type of soil in question (O'Neill loam, upland phase), $\rho c_p = 0.28$, as determined from six

different soil tests performed during the period covered by the data.

Thus, the value of soil heat flux is proportional to the area between profiles of temperature versus depth at the beginning and the end of the sampling period. The above, of course, is based on the assumption that $\partial T/\partial z = 0$ at some level z.

Soil temperatures were measured at 3.12, 6.25, 12.5, 25, 50, and 100 centimeters. If a maximum or minimum occurred at a depth of less than 100 centimeters, then the integral is represented by the area between the two profiles from the surface to the critical depth. If no maximum or minimum temperature occurred, then the integral was evaluated to 100 centimeters, provided the temperature at that depth did not vary significantly with time during the gas release period. Inasmuch as surface temperature was not measured, this point on the profile was obtained from a graph of surface temperature versus time of day for that location as given by an analog computer[4] from local input data.

Table 9.1 gives a summary of the analysis for 48 release periods for which complete data were available. The fluxes in this table are given in kilocalories per square centimeter per second. To facilitate comparison of these fluxes with values determined by the University of Wisconsin group, the fluxes are presented in calories per square centimeter per minute in Table 9.2.

The line of best fit* of the data of Table 9.1 is $y = .99x$, where y represents the net radiation values and x is the negative of the sum of the fluxes of latent heat, sensible heat, and soil heat. The average error (that is, between the net radiation values and the sum of the fluxes) is 0.43×10^{-3} cal/cm^2 sec. If release No. 10, which is obviously suspect, is omitted, the line of best fit is $y = 0.97x$ and average error is 0.36×10^{-3} cal/cm^2 sec.

*Determined by the method of least squares. The second significant figure in the equation of best fit should not be taken to imply an accuracy of 1 percent, but is given only as a means of comparison with other equations based on different methods of evaluating heat fluxes.

Table 9.1. Heat budget data collected by the Texas A&M Research Foundation

Gas Rel. No.	Δu $\frac{cm}{sec}$	$\Delta\theta$ °C	Δe mb	q_c $\frac{Kcal}{cm^2 sec}$	q_e $\frac{Kcal}{cm^2 sec}$	q_s $\frac{Kcal}{cm^2 sec}$	$\sum q_i$ $\frac{Kcal}{cm^2 sec}$	R_n $\frac{Kcal}{cm^2 sec}$	$R_n+\sum q_i$ $\frac{Kcal}{cm^2 sec}$
2	23	- .28	-.42	- .80	-2.32	.07	- 3.05	2.90	.15
7	54	-1.07	-.33	- 7.16	-4.28	-1.58	-13.02	12.80	.22
8	54	- .51	-.20	- 3.41	-2.59	.23	- 5.77	5.70	.07
9	84	- .53	-.23	- 5.52	-4.64	-1.18	-11.34	11.40	- .06
10	57	- .90	-.13	- 6.36	-1.78	-1.39	- 9.53	12.80	-3.27
15	40	- .70	-.09	- 3.47	- .86	-1.11	- 5.44	5.00	.44
16	42	-1.03	-.23	- 5.36	-2.32	-2.38	-10.06	10.00	.06
19	73	- .60	-.10	- 5.43	-1.75	-1.08	- 8.26	8.10	.16
20	112	- .83	-.05	-11.53	-1.34	-1.43	-14.30	13.70	.60
21	72	.10	-.01	.89	- .17	.22	.94	- .90	- .04
22	83	.15	-.02	1.54	- .40	.28	1.42	- 1.40	- .02
25	34	- .52	-.48	- 2.19	-3.92	.03	- 6.08	6.20	- .12
26	79	- .63	-.30	- 6.17	-5.09	-1.06	-12.92	12.60	.32
27	73	- .82	-.18	- 7.42	-3.15	-2.68	-13.25	12.30	.95
30	83	- .70	-.25	- 7.20	-4.98	-1.52	-13.70	12.90	.80
31	99	- .38	-.14	- 4.66	-3.33	- .95	- 8.94	9.20	- .26
32	20	.33	-.06	.82	- .29	.99	1.52	- 1.30	- .22
33	90	- .48	-.30	- 5.36	-6.48	.78	-11.06	10.90	.16
34	110	- .55	-.15	- 7.50	-3.96	- .35	-11.81	11.30	.51
35s	44	.12	-.04	.65	- .42	.76	.99	- .70	- .29
35	10	.12	.00	.15	.00	.82	.97	- .91	- .06
36	16	.23	-.06	.46	- .23	.61	.84	- .85	.01
38	48	.10	.00	.60	.00	.35	.95	- .85	- .10
39	22	.26	-.02	.71	- .11	.78	1.38	- 1.35	- .03
40	20	.23	-.04	.57	- .19	.70	1.08	- 1.14	.06
41	42	.16	-.01	.83	- .10	.51	1.24	- 1.23	- .01
42	70	.15	-.01	1.30	- .17	.26	1.39	- 1.92	.53
43	65	- .83	-.17	- 6.69	-2.65	- .63	- 9.97	10.80	- .83
44	71	- .85	-.07	- 7.48	-1.19	-1.35	-10.02	9.70	.32
45	70	- .20	-.03	- 1.74	- .50	.66	- 1.58	1.40	.18
46	66	.13	-.04	1.06	- .63	1.34	1.77	- 1.40	- .37
48s	38	- .77	-.34	- 3.63	-3.10	-1.54	- 8.27	7.00	1.27
48	91	- .51	-.11	- 5.75	-2.40	-1.01	- 9.16	8.10	1.06
49	82	- .76	-.15	- 7.73	-2.95	-1.67	-12.35	12.90	- .55
50	81	- .90	-.13	- 9.04	-2.53	-1.33	-12.90	12.80	.10
51	82	- .67	-.13	- 6.81	-2.56	- .52	- 9.89	8.80	1.09
52	55	-1.25	-.19	- 8.52	-2.51	- .68	-11.71	11.00	.71
53	21	.43	-.03	1.12	- .15	.98	1.95	- 1.50	- .45
54	46	.17	.00	.97	.00	.67	1.64	- 1.70	.06
55	69	.15	.00	1.28	.00	.55	1.83	- 1.50	- .33
56	56	.10	.04	.69	.54	.64	1.87	- 1.40	- .47
57	85	- .13	-.02	- 1.37	- .41	.34	- 1.44	1.30	.14
59	26	.26	-.01	.84	- .06	.58	1.36	- 1.40	.04
60	54	.17	-.01	1.14	- .13	.52	1.53	- 1.40	- .13
61	96	- .70	-.08	- 8.33	-1.84	-1.21	-11.38	11.90	- .52
62	63	- .37	-.17	- 2.89	-2.57	- .60	- 6.06	7.20	-1.14
63	3	.83	.47	.31	.34	.95	1.60	- 1.10	- .50
64	3	.43	.18	.16	.13	.96	1.25	- .50	- .75

Table 9.2. Heat budget data collected by the Texas A&M Research Foundation

Gas Release No.	q_c $\frac{cal}{cm^2 min}$	q_e $\frac{cal}{cm^2 min}$	q_s $\frac{cal}{cm^2 min}$	R_n $\frac{cal}{cm^2 min}$
2	-.048	-.139	.004	.174
7	-.430	-.257	-.095	.768
8	-.205	-.155	.014	.342
9	-.331	-.278	-.071	.684
10	-.382	-.107	-.083	.768
15	-.208	-.052	-.067	.300
16	-.322	-.139	-.143	.600
19	-.326	-.105	-.065	.486
20	-.692	-.080	-.086	.822
21	.053	-.010	.013	-.054
22	.092	-.024	.017	-.084
25	-.131	-.235	.002	.372
26	-.370	-.341	-.064	.756
27	-.445	-.189	-.161	.738
30	-.432	-.299	-.091	.774
31	-.280	-.200	-.057	.552
32	.049	-.017	.059	-.078
33	-.322	-.389	.047	.654
34	-.450	-.238	-.021	.678
35s	.030	-.025	.046	-.042
35	.009	.000	.049	-.055
36	.028	-.014	.037	-.051
38	.036	.000	.021	-.051
39	.043	-.007	.047	-.081
40	.034	-.011	.042	-.068
41	.050	-.006	.031	-.074
42	.078	-.010	.016	-.115
43	-.401	-.159	-.038	.648
44	-.449	-.071	-.061	.582
45	-.104	-.030	.040	.084
46	.064	-.038	.080	-.084
48s	.218	-.186	-.092	.420
48	-.345	-.144	-.061	.486
49	-.464	-.177	-.100	.774
50	-.542	-.152	-.080	.768
51	-.409	-.154	-.031	.528
52	-.511	-.151	-.041	.660
53	.067	-.009	.059	-.090
54	.058	.000	.040	-.102
55	.077	.000	.033	-.090
56	.041	.032	.038	-.084
57	-.082	-.025	.020	.078
59	.050	-.004	.035	-.084
60	.068	-.008	.031	-.084
61	-.500	-.110	-.073	.714
62	-.173	-.154	-.036	.432
63	.019	.020	.057	-.066
64	.010	.008	.058	-.030

Figure 9.3 is a scatter diagram of the data of Table 9.1.

A comparison of Eq. (40) with the Thornthwaite-Holzman evaporation formula shows that the latter relation differs from the former by a constant factor. The equations are, respectively,

$$q_{1e} = \sigma/3\nu \Delta u \rho' \tag{46}$$

$$q_{2e} = (pk^2 \Delta u \Delta h)/(\ln 2)^2 \tag{47}$$

where Δh is the difference in specific humidity between elevations z and 2z, and all other symbols have the meanings previously used. Replacing h in Eq. (47) by the ratio of absolute humidity to air density

$$q_{1e}/q_{2e} = \sigma/\nu \, (\ln 2)^2/3k^2 \ . \tag{48}$$

That is,

$$q_{1e} \doteq \sigma/\nu \, q_{2e} \tag{49}$$

At 20°C, the ratio of σ/ν is equal to 1.6 or

$$q_{1e} \doteq 1.6 \, q_{2e} \tag{50}$$

Hence, the evaporation amount and the flux of latent heat, as computed by the developments in this paper, are approximately 50 percent greater than the corresponding values obtained by the Thornthwaite-Holzman equation.

The sensible heat flux, according to the developments of this paper, also differs from the usual computations based on equivalence of the eddy conduction of heat and momentum by approximately 50 percent. That is,

$$q_{1h} = K_H \, c_p \, \rho \, d\theta/dz \tag{51}$$

where K_H is the eddy coefficient for heat. Assuming that $K_m = K_H = ku_* z$, where the subscript m refers to momentum, then

$$q_{1h} = ku_* \, z \, c_p \rho \ d\theta/dz \tag{52}$$

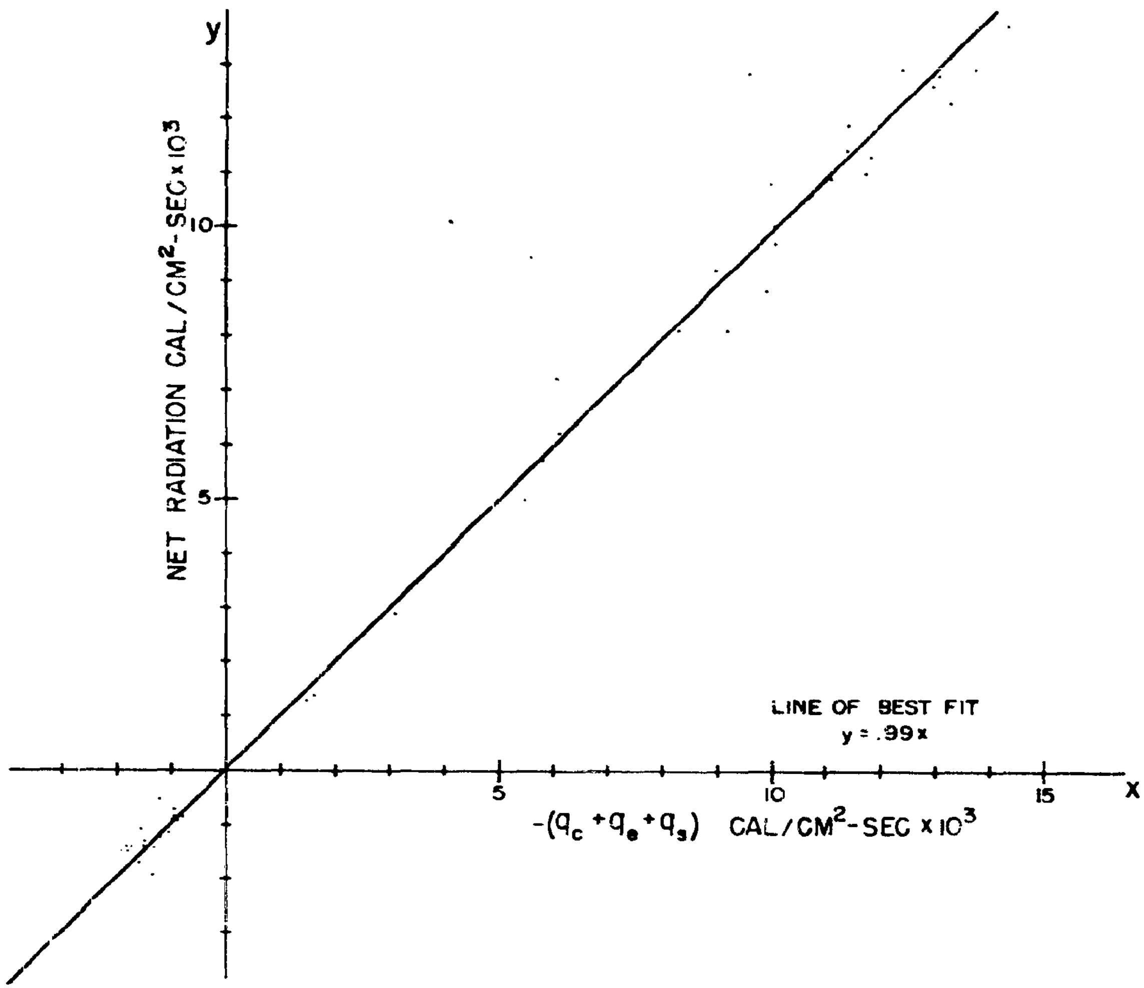

Figure 9.3 Net radiation vs. summation of heat fluxes, O'Neill, Nebraska, Summer of 1956, $K_M \neq K_H \neq K_W$

Comparing this with Eq. (29)

$$q_{2h} = \nu_c \, r(z/\delta) \, \rho \, c_p \, d\theta/dz$$

and using Eq. (20) to evaluate ku_*,

$$q_{1h}/q_{2h} = \nu/\nu_c = K_m/K_H, \tag{53}$$

which is the Prandtl number for air (.711). Hence,

$$q_{2h} = 1.4 q_{1h}, \tag{54}$$

or, as noted above, the sensible heat flux based on the reasoning of this paper is approximately one and one-half times the flux computations based on equivalence of the Austauch values for heat and momentum. Figure 9.4 is a scatter diagram of the O'Neill data based on the latter concept.

The supposition that the exchange coefficients for heat and momentum are equal or nearly so probably dates from the Reynolds' analogy, that is,

$$\tau/\rho = (\nu + K) \, du/dz = K_m \, du/dz \tag{55}$$

and

$$-q/c_p\rho = (\nu_c + K) \, d\theta/dz = K_H \, d\theta/dz. \tag{56}$$

Assuming that ν and ν_c represent insignificant contributions to the coefficients, K_H and K_m should be nearly equal.

The development used in this paper is equivalent to the postulate that

$$\tau/\rho = K \, du/dz = K_m \, du/dz, \tag{57}$$

and

$$-q/\rho \, c_p = \nu_c K \, d\theta/dz = K_H \, d\theta/dz, \tag{58}$$

hence, using Eqs. (9) and (29),

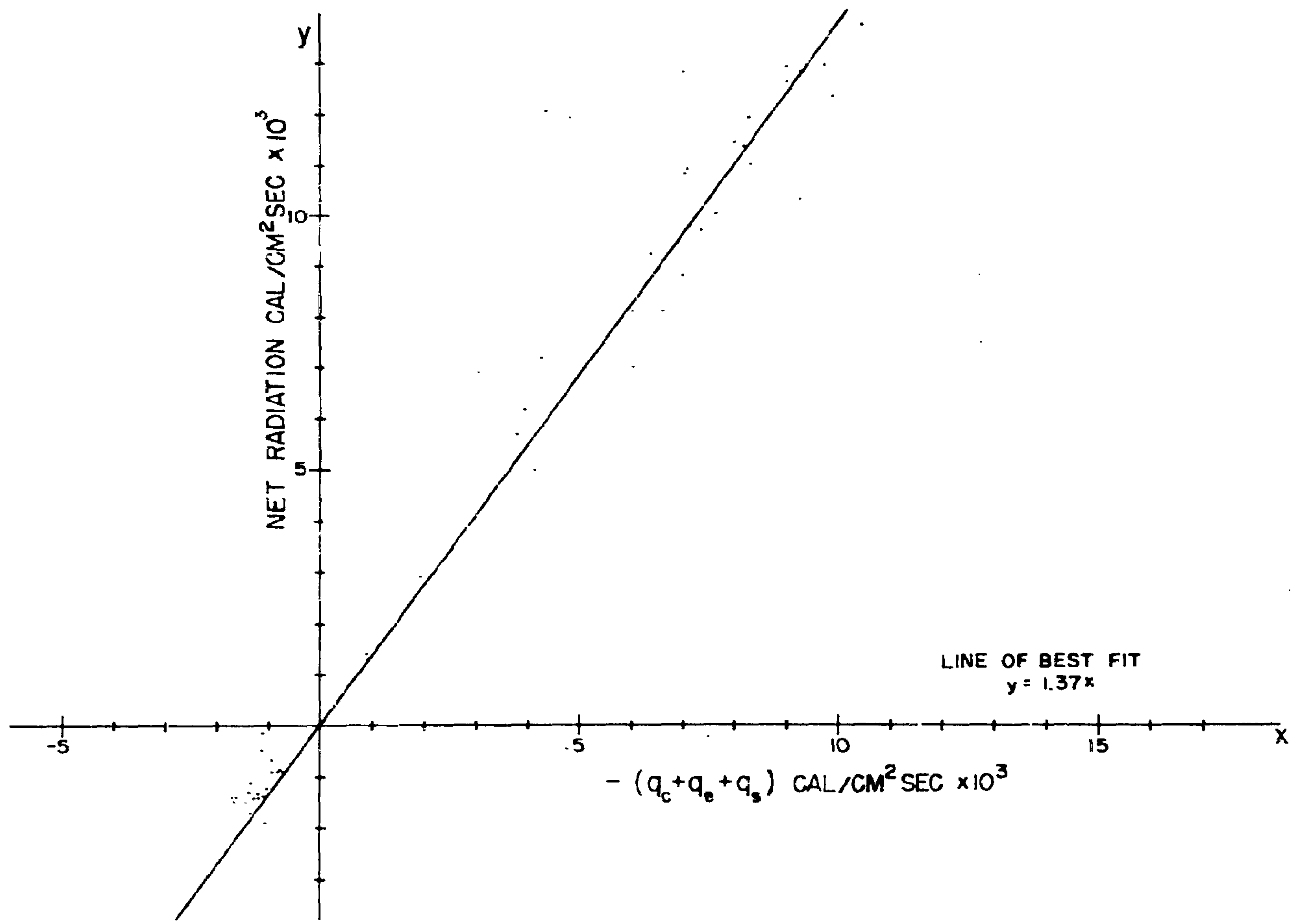

Figure 9.4 Net radiation vs summation of heat fluxes, O'Neill, Nebraska, Summer of 1956, $K_M = K_H = K_W$

$$K_m/K_H = \nu/\nu_c. \tag{59}$$

It is not intended to imply that the equivalence of the eddy coefficients for momentum and heat has been universally accepted in the past. Swinbank[6] from experiments conducted in Australia says "... there is a certain notable consistency about the manner in which K_H exceeds K_m ... Not only is this order of the coefficients maintained from one occasion to another, but also, broadly, the proportionality among them." From five measurements of K_m and K_H, his average ratio is

$$K_H/K_m = 1.8, \tag{60}$$

which is certainly of the magnitude of the ratio of ν_c to ν.

Data obtained by Rider[4] at Cardington, England, also supports this value of the ratio of K_m and K_H, although Rider did not interpret the results as support for the non-equivalence of the two coefficients. From averaging of nine evaluations of K_H and K_m (at 75 centimeters) from observed energy balance computations, Rider finds as an average ratio

$$K_m/K_H = .70.$$

While this value is indeed near unity, it is remarkably near the Prandtl number (.711) for air.

While detailed profiles of wind, temperature, and humidity have been utilized in verifying the turbulent transfer equations, the equations themselves require measurements at only two levels. Since measurement of a detailed profile requires a large number of highly accurate instruments and a comparable amount of technical time and attention, it would seem important to determine the degree of accuracy with which the various terms in the energy budget would have balanced had only two levels been available. Further, the data available should be sufficient to determine the optimum levels at which measurements could have been made.

The matter of optimum levels must require a compromise which will minimize three possible sources of error. First, the lowest level needs to be far enough above the surface that irregularities in that surface do not cause an appreciable uncertainty in determining the height of that level. Second, the difference in height between the two levels needs to be sufficiently great (in terms of doubled levels) so that errors caused by instrument inaccuracies and sampling errors are not too great. Third, the top level needs to be as low as possible so as to avoid the effect of buoyancy.

To study the combined effect of these three error sources, the data of the previous section have been treated in the following way. Values of Δu, $\Delta\theta$, and Δe have been obtained from the 21 pairs of levels; 25 to 50 cm, 25 to 100 cm, 25 to 200 cm, 25 to 400 cm, 25 to 800 cm, 25 to 1600 cm, 50 to 100 cm, 50 to 200 cm, 50 to 400 cm, 50 to 800 cm, 50 to 1600 cm, 100 to 200 cm, 100 to 400 cm, 100 to 800 cm, 100 to 1600 cm, 200 to 400 cm, 200 to 800 cm, 200 to 1600 cm, 400 to 800 cm, 400 to 1600 cm, and 800 to 1600 cm. The number of Δu's, $\Delta\theta$'s and Δe's, obtained in this manner (per pair of levels) that fall within 10 percent of the corresponding profile determinations are shown in Table 9.3.

As can be seen from this table, the levels at 25 and 100 cm appear to give the most satisfactory representation of the entire profiles. This is further substantiated by Table 9.4 which lists the best fit equations and average error for the four best level pairs, as well as that obtained from use of the profiles to determine Δu, $\Delta\theta$, and Δe.

9.7 Conclusion

The method developed in this paper appears to be satisfactory for calculating the turbulent transport of sensible and latent heat over the range of conditions represented by the data available.

However, since it differs from earlier methods by approximately 50 percent and since the test data are restricted to a summer season with exclusively southerly winds, it would appear desirable that it be tested further, preferably by other workers in the field.

Table 9.3. Percentage of double-level values within 10 percent of profile values

Level Pair (cm)	Δu cm/sec	$\Delta\theta$ °C	Δe mb	%	Level Pair (cm)	Δu cm/sec	$\Delta\theta$ °C	Δe mb	%
25-50	17	19	19	38	100-200	15	12	10	26
25-100	25	25	18	47	100-400	15	14	8	26
25-200	28	20	17	45	100-800	8	8	15	22
25-400	24	18	11	37	100-1600	7	8	12	19
25-800	12	17	11	28	200-400	12	9	9	21
25-1600	12	15	15	29	200-800	6	10	12	19
50-100	18	13	8	27	200-1600	3	6	14	16
50-200	17	13	13	30	400-800	4	5	6	10
50-400	19	17	11	33	400-1600	4	4	6	10
50-800	10	11	12	23	800-1600	4	3	6	9
50-1600	9	8	8	17					

Table 9.4. Statistical analysis of heat budget balance

Method	Line of Best Fit*	Average Error (cal/cm^2 sec)	Levels Employed
CLASSICAL	y = 1.37X	1.60×10^{-3}	Profiles
DISTORTED AREA	y = .92X	1.14×10^{-3}	25-50 cm
DISTORTED AREA	y = 1.0 X	1.06×10^{-3}	25-100 cm
DISTORTED AREA	y = 1.0 X	1.25×10^{-3}	25-200 cm
DISTORTED AREA	y = 1.0 X	1.40×10^{-3}	25-400 cm
DISTORTED AREA	y = .99X	$.43 \times 10^{-3}$	Profiles

*Line of regression

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CHAPTER 10

HEAT BUDGET DETERMINATIONS MADE BY THE UNIVERSITY OF WISCONSIN GROUP

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10.1 Instrumentation

The instrumentation used in heat budget determinations during Project Prairie Grass was, with two exceptions, the same as that used by the University of Wisconsin during the Great Plains Turbulence Field Program in 1953.[1] The exceptions are as follows:

a. In 1953 the thermocouples in the psychrometers were wired to give the dry bulb temperature difference and the difference in the wet bulb depressions. During these experiments the thermocouples were wired to give the dry bulb temperature difference and the wet bulb temperature difference so that the vapor pressure difference is given by the relation

$$\Delta e = (K + k)\,\Delta T_w - k\,\Delta T_d \qquad (1)$$

where k is the psychrometric constant and K is the slope of the vapor pressure vs. temperature curve at the mean wet bulb temperature.

Every 10 minutes the positions of the two psychrometers were reversed but the connection to the recorder was not. This has the effect of doubling the sensitivity and yet eliminating dead zone and zero errors. Therefore, the vapor pressure and temperature gradients obtained during the Prairie Grass experiments are more accurate than those obtained in 1953. This is especially true during those times that the gradient is small.

b. Soil heat flow was obtained by measuring the change in the heat content of the layer 0-5 cm <u>and</u> the heat flux through the -5 cm

level. The change in mean temperature of the 0-5 cm layer was measured using 12 space-integrating thermometers similar to those used in 1953. Instead of a manual balancing of a Wheatstone bridge, the out-of-balance current was recorded on the 12-point Brown recorder. The out-of-balance current depends on battery voltage as well as resistance; however, the former was held constant by employing mercury alkaline batteries. The heat flow through the -5 cm layer was measured using 5 heat flux plates connected in series. The soil term G listed in the tables in Section 10.2 is the sum of the change in the heat content of the layer 0 to -5 cm and the heat flux through the -5 cm level.

10.2 Heat Budget Data

The heat budget values listed in Table 10.1 are 20-minute averages centered, in each case, on the period of gas release. Estimated values are shown in parentheses. Missing values, due to instrument failure, are denoted by dashes. Positive signs indicate fluxes toward the air-earth interface; negative signs indicate fluxes away from the interface.

Table 10.1 Heat budget data* collected by the University of Wisconsin

Gas Release Number	Date	Time (CST)	I	R_N	L	E	G
3	7/5	2200		-.10			
4	7/6	0100		-.10			
5	7/6	1400	1.30	1.08			
6	7/6	1700	.73	.50			
7	7/10	1400	1.35	.82	-.39	-.26	-.12
8	7/10	1700	.75	.36	-.23	-.12	.01
9	7/11	1000	1.06	.61	-.30	-.18	-.13
10	7/11	1200	1.23	.76	-.38	-.24	-.14
11	7/14	0800	.72	.39	-.21	-.12	-.05
12	7/14	1000	1.15	.73	-.38	-.21	-.14
13	7/22	2000	.03	-.08	.01	0	.06
14	7/22	2200	0	-.07	.01	.01	.05
15	7/23	0800	.70	.38	-.19	-.08	-.10
16	7/23	1000	1.15	.70	-.36	-.18	-.16
17	7/23	2000	.05	-.06	0	.01	.05
18	7/23	2200	0	-.09	--	--	.04
19	7/25	1100	1.10	.69	-.40	-.16	-.14
20	7/25	1300	1.30	.85	-.52	-.26	-.06
21	7/25	2200	0	-.05	.02	.01	.02
22	7/26	0000	0	-.07	.02	.01	.05
23	7/29	2100	0	-.09	.04	.02	.02
24	7/29	2300	0	-.08	.03	.02	.02
25	8/1	1300	.72	.46	-.19	-.23	-.04
26	8/2	1200	.86	.61	-.20	-.33	-.08
27	8/2	1400	.97	.64	-.19	-.37	-.08
28	8/3	0000	0	-.09	--	--	--
29	8/3	0200	0	-.06	--	--	.01
30	8/3	1300	1.22	.84	-.34	-.39	-.10
31	8/3	1500	.89	.58	-.25	-.31	-.03
32	8/6	2000	.02	(-.09)	--	--	.04
33	8/7	1300	1.09	.83	-.39	-.35	-.08
34	8/7	1500	1.10	.84	-.44	-.36	-.05
35	8/11	2130	0	-.06	.02	.01	.03
36	8/11	2330	0	-.07	.01	0	.05
37	8/12	0300	0	-.05	--	--	.02
38	8/12	0500	.01	-.07	--	--	.02
39	8/13	2230	0	0	-.01	-.02	.03
40	8/14	0030	0	-.01	-.01	-.02	.04
41	8/14	0300	0	-.01	-.01	-.01	.02
42	8/14	0500	0	0	-.01	-.01	.02

Table 10.1 Heat budget data* collected by the University of Wisconsin (cont)

Gas Release Number	Date	Time (CST)	I	R_N	L	E	G
43	8/15	1200	1.11	.93	--	--	--
44	8/15	1400	1.13	.93	--	--	--
45	8/15	1200	.41	.25	--	--	--
46	8/15	1845	.05	-.03	--	--	.04
47	8/20	1000	.85	.45	-.21	-.14	-.11
48	8/21	0900	.39	.21	-.11	-.05	-.04

* All heat budget entries are in langleys per minute.
I represents insolation
R_N represents net radiation
L represents convective heat transfer
E represents evaporation
G represents soil heat transfer
( ) denotes estimated value
-- denotes missing data due to instrument failure

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CHAPTER 11
OPTICAL MEASUREMENTS OF LAPSE RATE

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11.1 Introduction

Detailed and very accurate observations of temperature structure in the lowest 50 cm of the atmosphere have been made above a cold water surface by an optical method.[1] These observations reveal a minor anomaly in the temperature profile at a height of about 10 cm of air (equivalent to an optical path length of 10^{-4} gm cm^{-2} of water vapor) which is consistent with simple numerical calculations based on extrapolated radiative absorption coefficients for water vapor. At this height above a cold surface, the air cools by radiation at several degrees Centigrade per hour; and, this cooling is reflected in the observed anomaly in the temperature profile.

Optical observations were incorporated in Project Prairie Grass to determine the detailed temperature structure above a warm land surface. The method used was essentially that described in reference 1, but certain modifications in detailed technique were necessary. The instrument used was a field artillery range finder operated in the vertical position. In lapse conditions the two light paths from instrument to target diverge from their respective straight-line directions as shown in Figure 11.1, whereas in inversions the light paths converge from their respective straight-line directions. The instrument is mechanically

* Personnel of the Texas A&M Research Foundation, under the direction of Professor Maurice Halstead, constructed the optical targets and made the time series observations.
Max Scoggins, General Electric Company, Richland, Washington, helped in installation of the equipment and in making the profile observations.

limited to measuring converging angles; consequently, in lapse conditions it was necessary to use targets separated by a vertical distance less than the separation of the lenses. The separation used in lapse conditions was 90 or 95 cm, whereas the separation of lenses is 100 cm. For this reason, in lapse conditions the upper path sloped slightly with respect to the lower path, but not enough to affect the measurements appreciably. From Figure 11.1 and Eq. (1) of reference 1, it follows that

$$h_1' = \frac{h_1 x'}{x} = \frac{xx'(n-1)}{2nT}\left[\frac{g}{R} + \left(\frac{\partial T}{\partial z}\right)_1\right] \tag{1}$$

$$h_2' = \frac{h_2 x'}{x} = \frac{xx'(n-1)}{2nT}\left[\frac{g}{R} + \left(\frac{\partial T}{\partial z}\right)_2\right] \tag{2}$$

where n represents index of refraction for air; T, absolute temperature; z, height coordinate; x, horizontal distance between instrument and target; and x', apparent distance to point of convergence of tangent lines (instrumental reading). Also, Figure 11.1 shows that

$$h_2' - h_1' = (Z-L)\frac{x'}{x} - Z \tag{3}$$

where L represents the vertical separation at the target lines and Z the vertical separation of the lenses. Substitution of Eqs. (1) and (2) in Eq. (3) gives

$$\left(\frac{\partial T}{\partial z}\right)_2 - \left(\frac{\partial T}{\partial z}\right)_1 = \frac{2nT}{x(n-1)}\left[\frac{Z-L}{x} - \frac{Z}{x'}\right] \tag{4}$$

For L = Z, Eq. (4) reduces to Eq. (5) of reference 1. Nine targets, each consisting of two (or more) horizontal black lines on white backgrounds were mounted at varying distances from the instrument. The black lines are indicated as target lines in Figure 11.1. Flashlight bulbs were installed at a vertical separation of 100 cm for night observations. Heights of the lower black line, equal to height of the lower lens, were chosen as

indicated in the accompanying data. In order to minimize effects of inhomogeneities in terrain, targets were placed as close as was feasible to a radial line running outward from the instrument. For the first 50 yards the land was extremely flat, the main obstructions to vision being small tufts of grass. On July 11, the grass was cut to lawn height along the light path out to about 100 yards permitting observations at a mean height of about 6 cm above the soil. Between 50 and 300 yards the land was flat except for a few areas of small scale roughness. Between 300 and 500 yards a ridge in the terrain may have influenced the 500 yard (50 cm) readings. However, the portion of the light path near the target is less important than the portion near the lenses, so that the effect of inhomogeneous terrain probably was small compared with the effect of variations in time.

11.2 Observations

The differences in lapse rates at the heights of the upper and lower lenses computed from Eq. (1) are tabulated in Tables 11.1, 11.2, and 11.3. Five of the nine profiles are shown in Figure 11.2. On July 10 at 1715 CST, prior to grass cutting, the anomaly was unmistakable at about 16 cm. On July 11 and 12, after the grass was cut, the anomaly was present at a height of about 12 cm; but the height of the anomaly above the effective radiating surface was comparable to the earlier observations.

In order to develop the temperature profile from the differences in lapse rate, the lapse rate at one height must be known. The lapse rate at 150 cm was approximated by extrapolating the curves of the type shown in Figure 11.2 linearly to 150 cm and assuming that this value represents the lapse rate at this height. Although this assumption may be grossly in error, the lapse rate is in any case small enough in magnitude at this height that subsequent calculations are not significantly affected. Numerical integration then gives the temperature profiles shown in Figure 11.3. The anomaly is evident on all but the inversion profile, and in this case the data reveal a slight anomaly at about 25 cm height.

A time series of observations at 12 cm (50 yard range) was made on 25 July, 26 July, and 2 August. On 2 August four observations were taken during each 5 minutes for 25 minutes out of each hour between 1155 and 1620 CST. These data are tabulated and are shown in Figure 11.4. They show that the variations encountered in 25 minutes are as large as one-fourth to one-half of the difference on lapse rate, itself. It must be concluded that the profiles shown in Figures 11.2 and 11.3 are subject to error from time variation in lapse rate. However, the reality of the anomaly is not in doubt because the anomaly appeared consistently and because the anomaly in lapse rate exceeds the variation in time by roughly an order of magnitude.

REFERENCE

1. Fleagle, R. G., "The temperature distribution near a cold surface." J. Meteor. 13, 160-165, 1956.

Table 11.1 Values of $\Delta(\partial T/\partial z)$ Found by Optical Method*

Lower Lens Height	Distance	$\Delta(\partial T/\partial z)$						
(cm)	(yd)	(°C/cm)						
		1715 10 July	1110 11 July	1845 11 July	2155 11 July	1130 12 July	1550 12 July	2135 12 July
100	500	+.006						
50	500				-.008			-.027
50	300	.015	+.021 to .024	+.005	-.006	.00	+.011	-.110
30	200	.025	.040 to .049	.011	.00	+.050	.017	-.600 to +.004
20	125	.041	.059 to .069	.024	.00	.074 to .090	.029	+.007
18	75	.060						
17	50	.076						
15	75		.073 to .082	.042	-.025	.110	.040	+.018
14	30	.013						
12	50		.120 to .159	.050	-.048	.170	.045	-.380
12	20	.402						
10	30		.121	.00	-.066	.105	.016	.00
8	25			.027	-.080	.399	.096	-1.20
6	20		1.29	.096	-.092	.438	.204	-.48 to -2.1

Table 11.2 Values of $\Delta(\partial T/\partial z)$ Found by Optical Method*

Date	Time (CST)	Lower Lens Height (cm)	Distance (yd)	$\Delta(\partial T/\partial z)$ (°C/cm)
21 July	1300	6	20	+.280
	1309	12	50	.100
	1425	12	50	.255
23 July	0800	12	50	.073
	0803	6	20	.261
	0805	8	25	.140
	0808	10	30	.098
	0810	12	50	.110
	0813	15	75	.064
	0815	20	125	.050
	0819	30	200	.034
	0822	50	300	.020
	0905	8	25	.200
	0909	10	30	.160
	0913	12	50	.127
	0917	15	75	.098
	0921	20	125	.064
	0925	30	200	.047
	0955	12	50	.145
	1007	12	50	.138
	1015	12	50	.174
	1200	12	50	.150
	1210	12	50	.188
	1355-1400	12	50	.158, .171, .171, .175, .200
	1510	12	50	.160, .160, .135
	1555	12	50	.130, .138, .128
	1655	12	50	.105, .097, .103
	1755	12	50	.063, .065, .058
31 July	1130	6	20	.200

Table 11.3 Time Series of $\Delta(\partial T/\partial z)$ at Height of 12 cm

Date	Time (CST)	$\Delta(\partial T/\partial z)$ (°C/cm)	Date	Time (CST)	$\Delta(\partial T/\partial z)$ (°C/cm)	Date	Time (CST)	$\Delta(\partial T/\partial z)$ (°C/cm)
24 July	0555	-.005, +.003, -.003	24 July	2215	-.097, -.124, -.120	25 July	1315	.135, .143, .140
	0615	+.005, .002, .002		2255	-.096, -.100, -.102		1355	.123, .123, .125
	0655	.015, .022, .015		2358	-.133, -.146, -.150		1415	.120, .117, .119
	0717	.034, .040, .030	25 July	0015	-.130, -.104, -.128		1455	.119, .117, .115
	0755	.055, .055, .058		0100	-.107, -.126, -.098		1515	.123, .117, .115
	0815	.073, .071, .071		0115	-.127, -.137, -.140		1555	.108, .102, .109
	0855	.080, .078, .088		0155	-.157, -.128, -.126, -.130		1615	.094, .102, .096
	0915	.090, .083, .082		0215	-.197, -.193, -.222, -.257		1655	.088, .090, .086
	0955	.107, .112, .109		0255	-.140, -.156, -.157, -.152		1715	.080, .076, .080
	1015	.097, .097, .104		0315	-.150, -.138, -.142, -.126		1755	.046, .048, .039
	1055	.106, .106, .104		0355	-.130, -.132, -.138, -.113		1816	.053, .055, .058
	1115	.109, .118, .112		0415	-.112, -.121, -.075, -.092		1855	.025, .027, .036
	1155	.118, .119, .120		0455*	-.105, -.097, -.093, -.094		1917	.017, .025, .021
	1215	.135, .139, .140		0455*	-.004, -.014, -.010		1955*	.025, .023, .015
	1255	.148, .149, .154		0515	-.004, -.014, -.002		1955*	-.079, -.076, -.069, -.072
	1315	.144, .160, .156		0555	-.000, -.004, -.006		2054	-.107, -.092, -.101, -.100
	1355	.144, .144, .152		0615	.010, .020, .015		2124	-.096, -.082, -.075, -.094
	1415	.144, .152, .142		0655	.063, .063, .061		2155	-.050, -.103, -.081, -.066
	1455	.164, .148, .130		0715	.079, .074, .063		2255	-.113, -.098, -.094
	1515	.125, .168, .125		0755	.060, .065, .067		2315	-.112, -.112, -.107, -.111
	1555	.119, .117, .121		0815	.078, .068, .068		2355	-.071, -.063, -.063
	1755	.092, .095, .066		0855	.063, .061, .063	26 July	0015	-.036, -.031, -.047, -.047
	1815	.097, .092, .102		0915	.057, .061, .055		0056	-.053, -.056, -.057, -.059
	1855	.043, .060, .054		0955	.090, .092, .088		0150	-.052, -.063, -.047, -.036
	1915	.052, .060, .052		1015	.086, .092, .096		0215	-.054, -.052, -.052, -.053
	1955	-.011, -.016, -.009		1055	.124, .129, .134		0255	-.047, -.039, -.049, -.047
	2015	-.030, -.030, -.032		1115	.109, .092, .096		0315	-.058, -.050, -.051, -.047
	2055	-.192, -.180, -.184		1155	.134, .137, .140		0355	-.072, -.096, -.098, -.099
	2115	-.120, -.117, -.120		1215	.128, .134, .134		0415	-.100, -.080, -.102, -.107
	2155	-.094, -.102, -.130		1255	.126, .123, .129		0515	.017, .017, .017
	0555	.000, .009, .000						
	0615	.007, .013, .011						
	0655	.037, .034, .046						
	0715	.060, .071, .063						
	0755	.037, .031, .038						
	0815	.041, .045, .045						
	0855	.073, .075, .085						
	0915	.115, .115, .106						
	0955	.137, .125, .132						
	1015	.100, .097, .093						

*Observations were made at 0455 and 1955 on 25 July 1956 using both lights mounted 100 cm apart and black lines 90 cm apart. The members of each pair of observations differ significantly from one another. This indicates an error in one or both types of observation. An error in positioning of one of the target lights of two millimeters would result in an error 0.1C cm^{-1} in the lapse rate measurements. An error in positioning of this magnitude easily may have occurred, so that all nighttime observations may be in error by roughly -0.1C cm^{-1}.

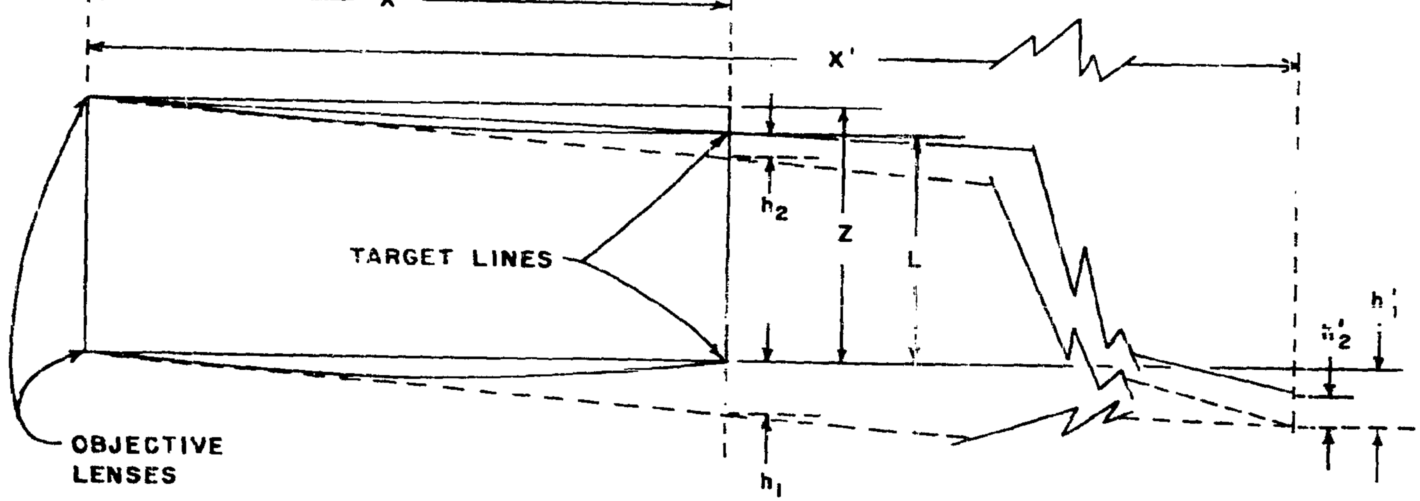

Figure 11.1 Light paths and related geometry.

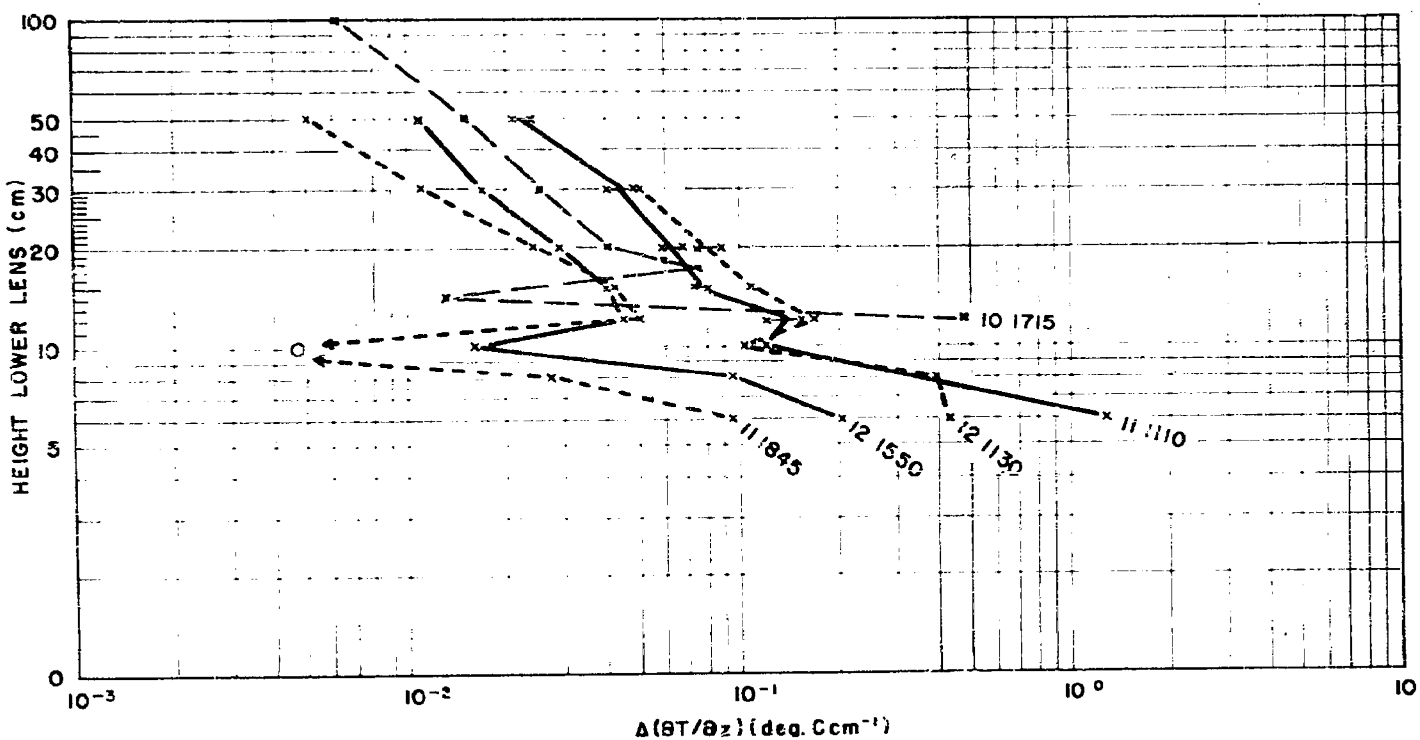

Figure 11.2 Optical observation of $\Delta(\partial T/\partial z)$, O'Neill, Nebraska, 10-12 July 1956.

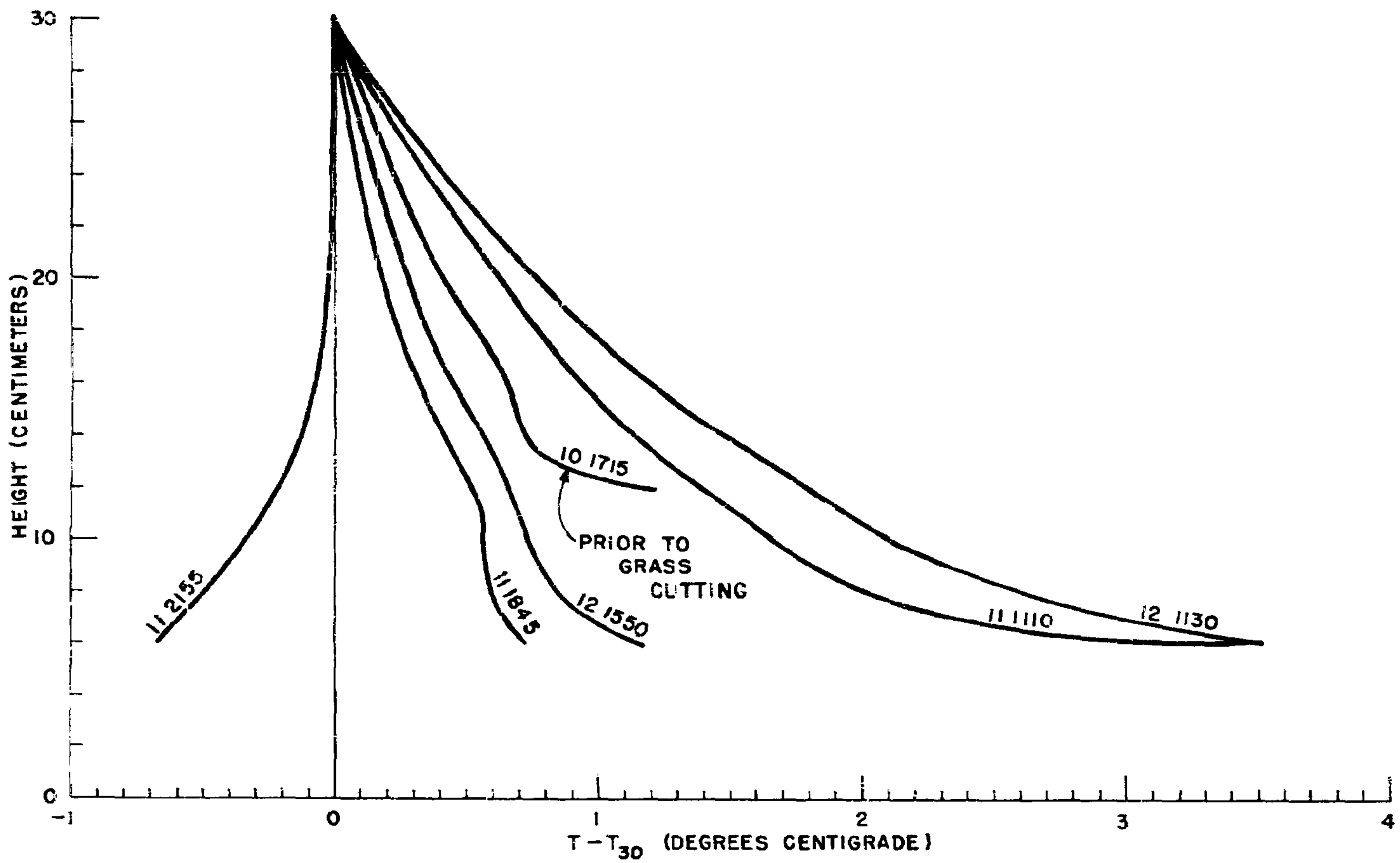

Figure 11.3 Optical temperature profiles, O'Neill, Nebraska, 10-12 July 1956.

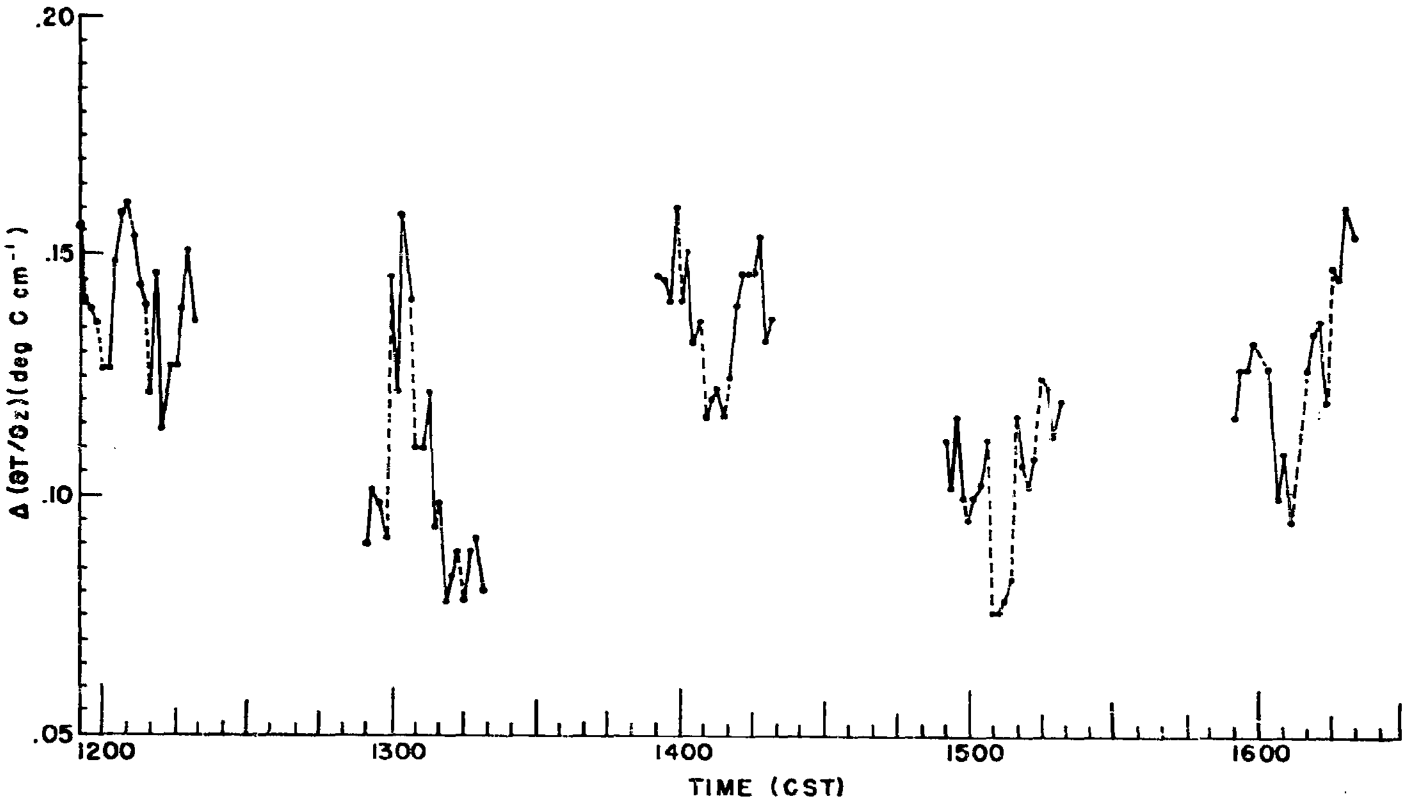

Figure 11.4 Time series of Δ (∂T/∂z) at a height of 12 cm, O'Neill, Nebraska, 2 August 1956.

CHAPTER 12
RAWINSONDE DATA

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The table in this chapter contains rawinsonde measurements made by the 6th Weather Squadron (Mobile), Tinker AFB, Oklahoma. A rawinsonde ascent was made at the test site for all gas releases except those numbered 35s and 48s. For each ascent, GMD-1A equipment was used and tabular data computed according to the instructions contained in the USWB Circular P and Air Weather Service Addenda. The computations were reviewed by an independent group using the same techniques.

Values of pressure, height, temperature and relative humidity are given for the significant and mandatory levels. The pressure is given in whole millibars, the height in meters above the ground (elevation of site above mean sea level is 603 meters), the temperature in tenths of degrees centigrade and the relative humidity in percent.

Values of the wind are given for standard heights. The height is given in meters above the ground, the direction in degrees (360 degree compass) to the nearest ten degrees, and the speed to the nearest tenth of a meter per second.

Table 12.1

Gas Release No. 1 — 3 July 1956 1050C

P (mb)	Z (m)	T (°C)	R.H (%)
945	0	22.5	65
934		20.0	67
900	420	17.6	78
860		14.4	91
850	906	13.8	91
800	1416	11.1	93
744		7.9	94
730		5.5	81
706		3.8	45
700	2522	4.7	52
694		5.5	58
638		1.6	61
600	3767	1.1	70

Winds

	Z (m)	ddd (deg)	ff (m/sec)
SFC	02	120	1.
	350	140	2.7
	630	160	2.2
	920	180	3.0
	1200	190	3.9
	1470	200	4.1
	1770	190	3.5
	2050	220	2.6
	2320	250	3.2
	2630	250	3.4
	2920	230	3.2
	3190	210	3.0
	3470	190	2.9
	3750	190	2.1
	4020	190	3.2

Gas Release No. 2 — 3 July 1956 1450C

P (mb)	Z (m)	T (°C)	R.H. (%)
945	0	24.0	66
933		21.8	61
900	423	19.0	72
850	912	14.7	86
844		14.3	88
800	1423	11.5	93
771		9.4	96
729		7.5	100
700	2530	5.4	100
679		3.9	100
655		3.5	100
620		- 1.6	100
609		- 1.5	97
604		0.0	89
600	3778	- 0.1	82

Winds

	Z (m)	ddd (deg)	ff (m/sec)
SFC	02	140	1.6
	370	120	2.0
	690	140	2.6
	960	170	3.1
	1250	160	2.6
	1530	160	2.1
	1820	170	2.3
	2120	190	2.2
	2410	230	2.7
	2710	250	3.9
	3030	270	8.8
	3320	280	10.6
	3620	250	9.0
	3930	270	10.3

Table 12.1 (Continued)

Gas Release No. 3

5 July 1956 2150C

P (mb)	Z (m)	T (°C)	R.H. (%)
948		19.8	95
940		24.8	61
900	454	21.9	62
882		20.5	63
850	948	18.1	54
837		17.1	50
805		14.5	58
800	1464	14.1	56
762		11.9	45
725		9.0	69
700	2578	6.5	62
695		5.9	62
672		4.0	64
636		0.8	54
600	3823	- 3.1	55

Winds

	Z (m)	ddd (deg)	ff (m/sec)
SFC	02	140	1
	250	140	3.2
	520	160	3.0
	810	180	1.9
	1080	140	1.8
	1380	130	2.2
	1630	190	0.6
	1920	270	0.6
	2220	300	4.5
	2460	290	5.0
	2710	280	5.2
	2980	290	5.0
	3230	300	5.2
	3490	300	6.0
	3730	280	8.2

Gas Release No. 4

6 July 1956 0050C

P (mb)	Z (m)	T (°C)	R.H. (%)
947		19.1	94
926		25.8	74
900	446	23.4	61
880		21.6	52
851		19.0	63
850	941	19.0	63
800	1459	15.6	56
731		10.6	45
700	2578	8.2	44
661		4.1	42
626		0.9	57
611		0.9	35
600	3831	- 0.1	35

Winds

	Z (m)	ddd (deg)	ff (m/sec)
SFC	02	180	2
	380	190	5.4
	630	180	4.3
	910	170	3.8
	1170	160	3.2
	No Data		
	2990	290	9.9
	3280	290	8.1
	3600	310	9.5
	3850	300	10.8

Table 12.1 (Continued)

Gas Release No. 5 6 July 1956 1350C				Gas Release No. 6 6 July 1956 1650C			
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
946	0	31.1	34	944	0	31.5	34
932		27.5	38	900	425	26.8	42
900	440	24.1	43	866		23.1	50
885		22.6	44	850	926		
856		22.0	33	822		20.8	39
850	938	21.5	34	800	1449	20.2	45
800	1462	17.8	47	734		13.1	38
720		11.5	67	700	2579	10.0	42
700	2591	9.4	71	660		6.0	50
660		4.9	76	600	3843	2.5	34
632		2.8	47				
600	3849	0.0	40				
	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	160	4	SFC	02	170	5
	280	170	7.4		300	180	11.8
	550	170	6.8		700	180	13.4
	850	190	6.2		Signal Failure		
	1130	200	6.2		No Data		
	1470	210	5.8				
	1800	210	5.9				
	2100	220	7.7				
	2440	220	11.0				
	2750	230	10.6				
	3050	240	9.8				
	3380	230	13.9				
	3700	230	16.0				
	4020	220	15.6				

Table 12.1 (Continued)

Gas Release No. 7 10 July 1956 1350C				Gas Release No. 8 10 July 1956 1650C			
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
946	0	31.0	30	945	0	31.6	30
938		26.8	28	930		28.9	30
904		24.5	35	900	433	25.9	35
900	439	24.1	37	850	931	20.9	42
850	935	19.5	49	837		19.4	45
800	1433	14.6	59	821		18.6	52
732		7.4	76	800	1451	16.7	55
702		5.5	61	705		8.0	66
700	2564	5.4	60	700	2571	7.3	65
666		4.1	23	674		4.5	59
655		5.1	mb	655		3.5	32
633		3.8	mb	644		4.5	21
600	3817	1.0	mb	600	3824	1.1	mb
	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	190	4.1	SFC	02	190	4.1
	310	210	6.1		330	170	4.7
	670	210	5.1		690	190	5.8
	1050	210	4.7		1060	200	7.2
	1435	220	4.8		1410	220	6.4
	1780	260	3.4		1710	230	6.8
	2130	300	5.6		2100	250	8.3
	2460	310	8.5		2400	290	9.4
	2800	310	9.4		2660	310	7.8
	3130	310	9.5		2940	330	6.7
	3450	310	9.6		3200	330	8.4
	3780	300	9.5		3460	320	7.8
	4120	300	10.1		3720	320	7.1
					4000	330	7.4

Table 12.1 (Continued)

Gas Release No. 9

11 July 1956 0950C

P (mb)	Z (m)	T (°C)	R.H. (%)
941		27.2	52
930		24.9	48
900	390	22.2	52
890		21.4	54
874		23.4	57
850	888	22.4	53
803		20.5	48
800	1414	20.2	47
716		12.5	35
700	2548	10.9	40
635		4.4	64
600	3812	0.7	66

Winds

	Z (m)	ddd (deg)	ff (m/sec)
SFC	02	180	4.6
	350	210	10.0
	680	220	8.2
	960	220	7.5
	1220	210	8.5
	1520	210	8.8
	1830	220	7.0
	2120	230	7.2
	2410	250	8.0
	2720	260	6.9
	3000	290	6.3
	3240	290	8.5
	3510	290	11.0
	3750	290	12.1
	4000	290	14.2

Gas Release No. 10

11 July 1956 1150C

P (mb)	Z (m)	T (°C)	R.H. (%)
941	0	30.8	44
925		26.5	47
900	394	24.4	52
850	892	19.9	63
846		19.4	64
832		20.5	57
800	1415	18.6	50
768		16.5	43
714		10.9	56
700	2545	9.7	52
663		6.1	46
600	3804	0.2	65

Winds

	Z (m)	ddd (deg)	ff (m/sec)
SFC	02	220	3.6
	280	230	6.0
	580	230	5.9
	900	220	6.0
	1220	210	8.0
	1600	210	7.8
	1950	220	6.8
	2300	240	6.7
	2670	250	7.5
	3000	260	9.5
	3330	270	11.2
	3690	280	11.2
	4070	290	13.2

Table 12.1 (Continued)

Gas Release No. 11 14 July 1956 0750C				Gas Release No. 12 14 July 1956 0950C			
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
944	0	24.5	66	944	0	30.0	48
933		22.4	65	930		26.0	56
902		22.8	68	900	421	22.9	67
900	417	22.8	68	898		22.6	68
850	916	21.7	48	890		23.5	64
818		20.8	34	850	920	23.1	35
800	1442	19.4	36	843		23.1	30
727		12.2	42	800	1446	19.9	30
700	2570	9.4	52	752		15.8	32
664		5.3	63	700	2577	10.3	49
624		3.4	34	648		4.4	66
600	3820	1.2	48	624		3.2	42
				604		1.4	60
				600	3836	1.1	59
	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	180	4.6	SFC	02	190	3.6
	300	190	11.8		300	200	11.0
	630	210	14.7		680	200	12.6
	940	210	12.8		1030	200	12.5
	1280	210	10.0		1400	200	10.3
	1650	210	6.8		1780	210	6.5
	1980	210	4.7		2130	210	5.0
	2250	210	4.6		2470	220	4.4
	2600	230	3.5		2850	250	4.4
	2980	230	3.5		3270	280	5.2
	3350	280	6.5		3530	310	9.4
	3730	290	8.5		3850	290	9.8
	4080	300	10.6				

Table 12.1 (Continued)

Gas Release No. 13	22 July 1956	1950C		Gas Release No. 14	22 July 1956	2150C	
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
949	0	21.9	69	950	0	16.4	89
940		22.8	59	940		22.2	64
900	459	19.9	65	900	467	19.8	58
850	950	15.9	73	898		19.7	57
800	1462	11.8	82	860	957	15.7	70
747		7.1	92	802		11.5	86
700	2566	4.4	80	800	1468	11.4	85
685		3.4	70	700	2569	4 0	77
645		- 0.4	80	654		0.2	72
634		1.0	80	631		0.5	49
622		- 0.1	34	620		0.6	21
601		- 0.6	22	600	3807	- 0.8	mb
600	3807	- 0.6	mb				
	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	170	1.0	SFC	02	160	1.0
	350	180	4.6		200	170	4.8
	700	180	4 6		610	180	4.5
	1020	180	5.0		900	190	3.0
	1340	180	4 0		1210	230	3.2
	1660	180	3.0		1500	260	2.9
	1960	190	1.8		1800	270	1.3
	2270	200	1.1		2100	300	2.1
	2670	310	2.9		2390	310	5.0
	2860	320	4.7		2660	310	7.5
	3200	320	6.0		2930	310	8.2
	3520	340	7 6		3210	310	7.8
	3840	340	9.3		3500	310	7.0
					3800	330	8.3

Table 12.1 (Continued)

Gas Release No. 15 23 July 1956 0750C				Gas Release No. 16 23 July 1956 0950C			
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
949		21.0	64	948	0	26.5	48
940		19.4	66	935		23.3	54
924		21.1	67	900	454	20.8	60
900	458	20.8	59	850	945	16.7	69
897		20.7	58	841		15.9	70
853		17.0	66	810		14.4	33
850	948	16.8	65	800	1458	13.6	34
800	1462	13.0	48	769		10.9	38
728		7.2	19	728		7.1	59
700	2569	6.8	mb	715		6.7	50
698		6.7	mb	708		6.4	27
644		4.0	mb	700	2564	6.4	26
600	3820	0.0	mb	681		6.4	22
				658		3.9	46
				600	3812	0.5	37
	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	230	2.1	SFC	02	180	2.1
	300	230	4.4		300	200	2.6
	600	240	2.8		610	190	2.6
	910	230	1.8		950	190	2.0
	1210	230	1.0		1300	180	1.1
	1500	260	0.9		1650	360	4.2
	1800	330	2.0		1980	010	7.3
	2090	360	4.7		2280	010	10.6
	2380	360	7.8		2600	010	12.5
	2680	350	9.5		2910	010	13.5
	2980	350	10.7		3230	010	13.2
	3290	340	10.9		3570	010	12.4
	3580	350	10.0		3880	350	10.2
	3850	350	8.9				

Table 12.1 (Continued)

Gas Release No. 17 — 23 July 1956 1950C | Gas Release No. 18 — 23 July 1956 2150C

P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
943	0	28.0	39	943	0	23.6	54
928		29.0	32	926		27.6	35
900	414	27.0	35	900	411	26.0	33
850	916	23.1	40	898		25.9	33
804		19.5	43	850	911	23.1	39
800	1441	19.1	45	841		22.8	39
700	2571	9.8	64	800	1435	18.9	47
600	3829	- 0.7	85	700	2564	9.0	64
				684	2755	7.2	67

	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	170	2.1	SFC	02	180	2.1
	310	190	9.8		300	200	13.1
	620	200	1.5		650	220	15.2
	930	220	12.5		1000	240	13.2
	1280	230	13.6		1310	200	13.6
	1620	250	12.0		1670	280	15.0
	2000	270	10.4		2000	290	14.5
	2330	310	10.8		2310	300	14.5
	2670	320	13.0				
	3010	320	15.8				
	3350	320	16.8				
	3700	320	18.1				
	4060	230	18.9				

Table 12.1 (Continued)

Gas Release No. 19, 25 July 1956 1050C				Gas Release No. 20, 25 July 1956 1250C			
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
945	0	28.8	38	942	0	31.0	30
932		25.8	41	917		30.6	33
900	429	22.8	47	900	406	25.1	35
878		20.5	51	870		22.0	38
850	923	20.5	26	850	904	22.3	27
823		20.8	21	838		22.5	18
800	1447	19.1	24	804		21.2	23
711		11.9	38	800	1430	20.9	24
700	2577	11.1	36	700	2565	11.5	38
678		9.5	28	687		10.6	24
600	3844	2.4	30	610		2.6	31
				600	3827	1.8	34
	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	160	3.6	SFC	02	160	6.7
	320	170	6.3		360	180	12.8
	620	180	7.6		700	180	11.2
	900	180	8.8		1020	190	9.6
	1130	190	9.0		1370	200	6.8
	1380	190	6.6		1700	240	5.5
	1620	210	2.8		2050	250	5.1
	1820	220	2.0		2420	260	4.8
	2000	250	1.4		2770	270	5.7
	2280	300	2.0		3140	270	7.0
	2480	310	2.3		3380	270	7.4
	2700	300	2.4		3630	270	7.8
	2880	300	3.0		3900	290	10.0
	3080	290	4.5				
	3260	280	5.0				
	3430	250	4.0				

Table 12.1 (Continued)

Gas Release No. 21

25 July 1956 2150C

P (mb)	Z (m)	T (°C)	R.H. (%)
938	0	29.0	41
911		27.1	39
900	367	28.3	34
889		29.6	30
861		28.5	27
850	875	26.5	27
844		25.5	27
806		24.8	25
800	1408	24.2	26
728		16.8	35
700	2557	14.0	41
678		11.6	44
632		4.7	59
620	3563	3.0	70

	Winds		
	Z (m)	ddd (deg)	ff (m/sec)
SFC	02	180	4.1
	160	200	8.0
	370	220	11.3
	540	220	12.3
	780	230	12.3
	1030	250	14.4
	1300	260	17.0
	1630	260	14.0
	2020	260	15.0
	2380	265	20.8
	2660	260	17.5
	2950	270	9.0
	3150	270	12.0
	3340	260	18.5
	3550	260	10.5

Gas Release No. 22

25 July 1956 2350C

P (mb)	Z (m)	T (°C)	R.H. (%)
937	0	26.5	45
910		25.5	45
900	355	26.3	43
896		26.8	42
850	850	25.2	36
800	1390	23.4	27
749		19.0	29
700	2532	13.4	38
636		5.7	50
600	3800	2.0	55

	Winds		
	Z (m)	ddd (deg)	ff (m/sec)
SFC	02	170	4.6
	300	190	20.0
	660	200	25.0
	930	210	24.6
	1220	220	25.3
	1500	240	22.0
	1800	260	16.0
	2080	260	16.0
	2360	250	18.8
	2630	250	21.0
	2930	250	19.6
	3180	250	17.0
	3450	250	17.0
	3750	250	17.0
	4080	270	11.4

Table 12.1 (Continued)

Gas Release No. 23 29 July 1956 2050C				Gas Release No. 24 29 July 1956 2250C			
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
944	0	23.9	70	945	0	22.2	80
900	417	21.7	78	936		22.4	80
860		19.4	84	900	424	19.9	85
850	911	19.5	82	897		19.7	85
838		19.1	80	854		20.9	75
804		17.5	76	850	919	20.9	75
800	1432	17.6	70	815		19.5	65
776		18.6	47	800	1443	18.5	69
700	2507	11.9	45	774		16.3	72
696		11.4	44	750		15.9	64
685		10.1	54	700	2576	11.1	66
614		3.9	63	684		9.6	67
600	3837	2.2	65	659		7.0	57
				600	3842	1.0	72

	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	120	4.6	SFC	02	130	3.8
	290	130	13.1		290	150	13.3
	600	120	15.0		600	160	14.4
	890	090	11.5		930	190	13.7
	1190	070	11.5		1270	210	14.2
	1480	050	11.1		1620	230	12.4
	1730	020	7.8		1920	250	10.2
	2020	030	5.0		2270	260	8.1
	2290	030	4.1		2600	260	6.1
	2520	020	3.7		2910	260	5.3
	2820	010	5.3		3230	260	5.3
	3100	010	6.4		3590	270	5.7
	3360	360	6.6		3880	270	6.0
	3630	360	6.5				
	3920	360	6.0				

Table 12.1 (Continued)

Gas Release No. 25	1 Aug 1956	1257C		Gas Release No. 26	2 Aug 1956	1150C	
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
946	0	24.7	66	942	0	30.3	56
934		22.4	70	922		25.4	64
900	436	19.7	78	900	404	23.6	70
878		18.0	84	883		22.1	73
850	927	16.6	84	850	901	20.7	70
800	1443	13.9	84	800	1424	18.4	64
700	2550	8.2	83	790		18.0	62
694		7.8	83	705		10.6	78
636		3.8	83	700	2555	10.1	79
620		3.4	79	648		5.9	85
600	3819	1.8	78	600	3822	2.4	83

	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	180	2.1	SFC	02	170	3.6
	350	190	4.5		230	180	9.7
	680	200	6.1		500	190	11.2
	960	200	6.5		770	200	11.0
	1200	210	5.6		1030	200	11.5
	1450	210	5.9		1300	210	12.5
	1780	220	6.9		1500	210	13.8
	2120	220	7.3		1910	210	13.5
	2420	220	7.1		2210	210	13.5
	2720	220	9.0		2520	210	14.7
	3080	230	11.1		2820	230	16.0
	3460	220	9.3		3130	230	17.0
	3670	220	5.7		3420	230	17.0
	3990	220	5.5		3730	230	18.0
					4030	230	19.0

Table 12.1 (Continued)

Gas Release No. 27, 2 Aug 1956 1350C				Gas Release No. 28, 3 Aug 1956 0035C			
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
941	0	32.2	48	940	0	25.9	68
934		29.6	52	925		28.0	59
900	398	26.6	56	900	385	26.6	55
860	898	22.0	60	892		26.1	54
813		18.5	65	878		26.6	51
800	1421	18.6	56	850	889	24.2	51
700	2551	10.5	69	810		21.0	51
868		7.7	73	800	1416	20.0	54
600	3817	2.6	72	721		13.1	74
				700	2551	11.1	78
				630		4.1	90
				600	3818	1.9	89
	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	170	5.1	SFC	02	170	3.1
	[illegible]	190	9.2		300	200	13.2
	580	180	7.0		590	210	18.4
	880	180	8.6		830	210	22.2
	1200	190	12.0		1090	210	21.3
	1600	200	13.9		1320	210	20.5
	1800	210	14.0		1580	210	20.1
	2100	210	15.6		1870	220	21.5
	2420	210	17.0		2200	220	24.0
	2720	210	18.5		2490	220	20.0
	3020	220	18.5		2770	210	18.8
	3320	220	[illegible]		3020	210	18.5
	3620	210	[illegible]		3300	210	18.7
	3920	210	19.3		3550	210	18.7
					3820	210	17.0

Table 12.1 (Continued)

Gas Release No. 29 3 Aug 1956 0150C				Gas Release No. 30 3 Aug 1956 1250C			
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
941	0	25.5	61	941	0	34.6	36
928		26.6	56	932		31.6	42
900	393	25.4	54	900	401	28.7	49
893		25.1	53	850	906	23.9	56
870		25.1	48	846		23.5	57
850	895	23.8	50	800	1432	19.1	63
800	1422	20.4	54	757		14.8	70
787		19.4	55	732		14.3	60
700	2557	10.9	72	700	2564	11.5	62
668		7.5	80	630		4.8	68
601		1.9	79	607		3.7	66
600	3824	1.8	80	600	3834	3.0	66
	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	180	4.3	SFC	02	190	5.1
	300	200	16.0		290	190	9.5
	620	210	20.0		580	190	11.7
	950	210	23.0		880	190	11.8
	1270	210	23.8		1180	190	8.4
	1600	220	21.0		1450	200	8.6
	1900	220	19.0		1800	200	13.4
	2210	220	19.0		2150	210	18.5
	2530	220	18.0		2480	210	18.5
	2850	220	15.5		2780	210	18.5
	3150	210	16.2		3040	210	19.0
	3470	210	17.0		3290	210	21.0
	3780	200	19.0		3500	220	20.0
	4100	200	19.0		3810	220	20.5
					4100	220	20.8

Table 12.1 (Continued)

Gas Release No. 31 3 Aug 1956 1450C				Gas Release No. 32 6 Aug 1956 1950C			
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
941	0	34.0	37	945	0	24.3	36
932		31.5	40	933		27.0	35
900	400	28.8	46	900	430	24.7	38
850	906	24.2	56	850	929	21.0	43
800	1433	19.7	66	800	1450	17.3	48
738		13.6	80	783		16.0	49
700	2565	10.5	76	770		15.0	41
617		3.5	68	758		14.4	51
600	3833	2.7	72	700	2576	9.2	60
				647		4.1	67
				600	3834	0.3	53
	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	200	5.1	SFC	02	130	2.1
	320	200	9.7		300	170	11.0
	690	210	9.0		630	160	14.5
	1010	210	10.1		980	160	17.0
	1360	210	12.0		1300	150	16.0
	1690	210	12.0		1680	140	16.2
	2000	210	11.8		2030	130	16.2
	2300	210	12.9		2400	130	13.1
	2620	220	13.6		2720	140	8.8
	2930	220	15.9		3080	160	8.8
	3390	220	15.5		3470	220	9.6
	3620	220	13.5		3840	260	12.2
	3940	230	15.0				

Table 12.1 (Continued)

Gas Release No. 33

7 Aug 1956 1258C

P (mb)	Z (m)	T (°C)	R.H. (%)
944	0	28.8	48
900	422	24.2	49
894		23.6	49
864		23.3	38
850	921	22.2	40
800	1444	18.0	48
700	2570	9.0	66
677		6.9	70
640		5.5	51
600	3832	1.8	43

	Winds		
	Z (m)	ddd (deg)	ff (m/sec)
SFC	02	170	4.6
	300	170	13.3
	600	170	15.2
	960	170	14.5
	1320	180	14.5
	1700	190	14.0
	2080	180	8.4
	2450	150	5.3
	2830	150	7.2
	3170	170	8.0
	3470	200	7.8
	3800	230	7.3

Gas Release No. 34

7 Aug 1956 1455C

P (mb)	Z (m)	T (°C)	R.H. (%)
944	0	30.5	38
928		26.0	46
900	422	23.6	53
868		20.7	58
850	918	20.3	55
800	1440	18.7	42
708		18.6	41
700	2569	10.3	48
620		3.3	55
600	3833	1.0	57

	Winds		
	Z (m)	ddd (deg)	ff (m/sec)
SFC	02	170	4.6
	340	150	13.0
	620	160	15.4
	900	170	15.5
	1290	180	13.8
	1630	190	11.9
	1930	200	11.0
	2210	210	12.1
	2500	220	14.1
	2800	230	13.7
	3060	240	12.0
	3330	240	9.5
	3620	240	6.8
	3900	340	6.1

Table 12.1 (Continued)

Gas Release No. 35	11 Aug 1956	2122C		Gas Release No. 36	11 Aug 1956	2328C	
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
945	0	20.0	62	943	0	18.8	85
938		24.8	50	930		23.5	79
900	426			900	406	21.8	74
850	920			860		19.5	66
806		15.0	67	850	900	19.0	68
800	1436			800	1418	15.7	74
700	2549	5.4	90	738		11.3	83
682		4.9	77	700	2537	7.6	70
656		4.0	24	693		6.8	68
600	3799	1.3	mb	677		6.3	24
				650		6.0	mb
				618		3.4	24
				600	3794	1.3	30

	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	170	1.6	SFC	02	180	1.6
	300	160	6.1		350	180	11.3
	630	180	7.0		600	190	10.0
	940	200	7.0		880	200	8.0
	1240	220	8.6		1170	220	7.0
	1580	240	9.8		1420	240	9.0
	1950	250	10.8		1700	250	13.0
	2250	260	11.9		2000	260	15.7
	2510	260	11.5		2300	260	15.0
	2760	260	11.4		2600	260	13.3
	3000	270	11.2		2930	270	12.0
	3260	280	13.1		3270	280	12.0
	3480	290	16.2		3580	300	13.8
	3710	300	17.8		3900	300	16.2

Table 12.1 (Continued)

Gas Release No. 37 12 Aug 1956 0250C				Gas Release No. 38 12 Aug 1956 0450C			
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
942	0	20.0	75	942	0	20.0	81
912		22.8	77	905		22.5	55
900	308	22.2	71	900	395	22.5	51
883		21.3	61	886		22.5	45
850	894	19.3	61	852		20.5	45
823		17.6	62	850	891	20.3	45
800	1413	16.0	66	800	1411	16.9	59
726		11.0	81	735		12.1	78
702		9.3	69	712		10.5	54
700	2538	9.0	64	700	2534	9.1	59
677		7.6	23	673		6.0	66
622		2.0	30	656		5.0	34
600	3794	- 0.1	41	633		3.5	24
				600	3787	0.2	33
	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	180	3.1	SFC	02	180	3.6
	300	190	14.9		330	180	14.0
	630	100	15.8		680	150	18.3
	950	200	12.3		1020	200	19.7
	1240	220	13.4		1370	210	17.5
	1520	230	15.4		1670	230	12.5
	1830	250	14.8		1950	240	10.0
	2140	270	12.5		2300	250	8.8
	2410	270	11.2		2600	260	8.5
	2700	260	10.9		2900	240	10.0
	3000	260	9.0		3220	240	9.0
	3300	260	7.6		3480	240	10.0
	3640	260	7.4		3760	230	13.0
	3960	260	6.8		4000	230	14.6

Table 12.1 (Continued)

Gas Release No. 39	13 Aug 1956	2220C		Gas Release No. 40	14 Aug 1956	0020C	
P (mb)	**Z (m)**	**T (°C)**	**R.H. (%)**	**P (mb)**	**Z (m)**	**T (°C)**	**R.H. (%)**
948	0	20.5	41	948	0	20.6	62
937		25.4	38	940		25.5	49
930		27.4	35	932		27.6	40
900	457	25.6	30	900	457	25.1	42
886		24.6	28	850	955	21.0	46
850	955	21.9	36	805		17.0	49
800	1477	17.9	48	800	1476	16.9	50
761		14.5	56	763		15.0	56
700	2599	8.6	69	700	2598	8.4	49
680		6.4	71	670		5.8	46
637		2.5	26	628		0.1	53
600	3849	- 0.2	24	609		0.0	24
				600	3849	- 0.6	mb

	Winds				Winds		
	Z (m)	**ddd (deg)**	**ff (m/sec)**		**Z (m)**	**ddd (deg)**	**ff (m/sec)**
SFC	02	160	2.0	SFC	02	200	2.0
	420	150	10.3		300	200	12.8
	850	170	9.0		600	210	14.2
	1200	200	9.0		900	210	13.8
	1580	230	10.3		1230	210	12.3
	2030	260	12.0		1570	230	10.2
	2460	280	13.0		1870	270	9.5
	2780	290	13.0		2100	300	9.3
	3170	300	14.0		2470	310	11.4
	3580	300	14.6		2760	320	14.0
	4000	310	16.0		3080	320	15.5
					3400	320	16.5
					3700	320	15.5
					3990	320	12.5

Table 12.1 (Continued)

Gas Release No. 41 14 Aug 1956 0250C

P (mb)	Z (m)	T (°C)	R.H. (%)
947	0	20.0	66
933		24.2	60
915		26.0	40
900	446	25.3	40
850	946	22.8	36
840		22.2	36
800	1470	18.9	52
733		18.2	55
700	2597	9.3	59
696		8.9	59
600	3850	- 2.3	65

Winds

	Z (m)	ddd (deg)	ff (m/sec)
SFC	02	180	3.1
	280	210	13.2
	530	220	14.2
	830	220	14.0
	1130	240	12.2
	1450	260	11.6
	1780	270	10.8
	2100	280	12.0
	2430	290	12.8
	2730	290	14.0
	3050	300	14.2
	3400	310	15.0
	3680	310	15.0
	4000	310	16.5

Gas Release No. 42 14 Aug 1956 0450C

P (mb)	Z (m)	T (°C)	R.H. (%)
947	0	21.7	55
920		28.6	31
900	448	26.0	30
869		24.9	30
850	948	22.9	41
841		22.0	46
800	1473	20.0	53
792		19.5	54
733		12.7	67
711		11.1	53
700	2603	10.0	52
674		7.1	51
614		- 0.8	73
600	3858	- 2.0	69

Winds

	Z (m)	ddd (deg)	ff (m/sec)
SFC	02	210	4.6
	340	230	20.9
	690	230	20.6
	1020	240	16.3
	1330	260	17.1
	1680	260	16.5
	2000	270	14.0
	2330	270	12.4
	2630	270	11.0
	2940	280	12.0
	3270	290	12.0
	3590	290	14.0
	3910	300	15.5

Table 12.1 (Continued)

Gas Release No. 43				Gas Release No. 44			
15 Aug 1956 1150C				15 Aug 1956 1350C			
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
945	0	34.5	24	943	0	36.8	19
931		30.4	26	930		31.9	22
900	436	27.6	30	900	418	29.1	25
850	937	22.9	35	874		26.8	27
846		22.4	36	850	922	24.5	30
832		23.3	18	806		20.6	35
800	1462	20.1	24	800	1448	20.1	37
762		17.2	40	746		16.5	52
746		16.1	41	718		13.3	54
705		12.0	56	700	2585	11.9	43
700	2598	11.8	53	695		11.6	40
685		10.7	47	658		8.5	37
630		4.2	53	600	3853	1.2	64
600	3863	0.9	69				

	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	160	1.5	SFC	02	150	4.1
	280	160	5.0		280	150	6.0
	570	150	4.2		570	150	8.5
	750	140	5.0		880	160	9.2
	1130	150	5.8		1210	170	8.3
	1430	200	4.4		1550	200	7.7
	1720	220	5.7		1920	230	8.4
	2050	250	7.0		2300	25[illegible]	10.2
	2390	260	8.7		2650	250	11.9
	2700	260	9.8		3000	240	11.5
	3000	260	10.7		3380	240	10.2
	3300	260	11.2		3720	250	9.2
	3600	260	11.2		4080	250	10.1
	3910	260	11.2				

Table 12.1 (Continued)

Gas Release No. 45 15 Aug 1956 1658C				Gas Release No. 46 15 Aug 1956 1835C			
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
940	0	36.5	21	939	0	33.5	24
930		33.6	22	919		33.2	22
900	392	31.0	26	900	379	31.6	26
862		27.8	30	850	888	26.9	31
850	899	26.6	31	842		26.0	37
800	1429	22.0	40	800	1420	22.3	41
700	2569	12.0	59	778		20.4	44
600	3839	2.6	77	700	2564	12.9	62
				687		11.6	65
				656		7.6	63
				600	3834	1.9	71

	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	160	4.1	SFC	02	140	4.6
	310	160	7.4		300	140	11.2
	620	160	9.0		600	140	12.7
	980	160	9.2		900	160	12.3
	1300	170	9.5		1210	180	13.5
	1610	190	9.6		1570	190	12.9
	1870	210	8.5		1890	210	12.8
	2180	230	9.5		2210	220	14.0
	2470	230	12.0		2590	230	14.6
	2760	240	12.6		2910	240	14.0
	3020	240	11.3		3240	240	13.6
	3290	240	11.2		3570	250	13.6
	3550	240	13.5		3880	260	13.0
	3800	250	13.5				
	4060	260	13.9				

Table 12.1 (Continued)

Gas Release No. 47 20 Aug 1956 1005C				Gas Release No. 48 21 Aug 1956 0850C			
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
955	0	19.0	50	947	0	18.8	59
945		16.5	40	930		15.8	63
900	502	13.1	51	903	433	13.5	69
850	979	9.1	63	868		14.5	62
842		8.4	65	850	915	12.3	48
800	1477	4.9	60	849		12.3	48
754		0.9	56	824		10.5	51
729		- 0.4	75	812		10.9	22
708		- 1.8	43	800	1420	11.8	mb
700	2550	- 1.1	39	792		12.3	mb
694		- 0.5	34	756		11.6	mb
666		- 3.1	24	716		8.5	mb
645		- 3.3	mb	700	2532	8.0	mb
600	3768	- 6.5	mb	686		7.7	mb
				610		1.6	mb
				600	3787	0.5	mb
	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	250	3.1	SFC	02	180	5.7
	320	230	3.7		330	210	9.0
	690	250	2.5		680	230	10.8
	1050	260	0.8		1030	240	12.3
	1420	010	2.7		1400	250	11.0
	1800	350	2.8		1730	260	9.7
	2150	320	3.9		2050	260	9.0
	2530	320	6.5		2380	290	11.2
	2900	340	8.9		2730	290	14.0
	3270	340	9.5		3050	290	16.0
	3620	340	10.0		3400	290	16.5
	3990	340	11.4		3710	300	16.8
					4030	300	16.0

Table 12.1 (Continued)

Gas Release No. 49, 21 Aug 1956 1050C				Gas Release No. 50, 21 Aug 1956 1350C			
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
946	0	23.8	44	943	0	29.0	38
912		17.1	44	937		25.7	40
900	430	16.5	48	900	408	22.3	48
874		14.9	54	895		21.9	49
860		15.3	54	850	901	19.0	40
850	914	14.8	56	826		17.4	35
800	1424	11.2	65	800	1417	14.1	37
796		11.0	66	793		13.3	37
782		9.0	20	764		11.9	20
767		11.3	mb	742		11.9	mb
728		8.8	mb	700	2533	8.8	mb
715		9.8	mb	600	3790	0.9	mb
700	2533	8.6	mb				
608		1.4	mb				
600	3788	0.5	mb				

	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	180	5.7	SFC	02	200	5.1
	330	210	7.8		230	200	8.0
	700	230	10.5		480	220	8.0
	1050	250	12.2		700	240	7.0
	1400	260	13.8		950	250	9.7
	1780	260	13.3		1200	270	11.0
	2120	270	13.2		1480	280	11.0
	2480	280	13.2		1750	290	12.0
	2800	290	14.5		2010	300	13.5
	3130	290	15.3		2290	300	15.0
	3480	200	16.5		2590	300	14.8
	3800	290	17.5		2870	300	13.5
					3110	300	16.0
					3320	300	17.5
					3620	300	18.5
					3910	300	17.0

Table 12.1 (Continued)

Gas Release No. 51	21 Aug 1956	1520C		Gas Release No. 52	24 Aug 1956	1105C	
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
942	0	31.0	33	952	0	25.0	22
932		26.7	36	932		20.7	29
900	403	23.9	41	900	485	18.2	33
850	899	19.4	50	850	971	14.1	39
818		16.4	57	848		13.9	39
800	1417	14.6	60	800	1482	13.3	49
770		11.6	66	793		13.1	50
733		8.3	54	740		8.5	60
722		8.3	22	713		8.9	25
700	2530	7.6	mb	700	2593	7.4	42
695		7.5	mb	688		6.5	30
600	3784	0.8	mb	676		5.5	41
				600	3842	- 2.7	56
	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	240	4.6	SFC	02	140	3.1
	320	240	9.5		400	110	6.1
	680	250	13.0		760	110	5.0
	1010	250	13.5		1100	080	2.8
	1370	260	12.8		1460	340	3.6
	1710	270	10.4		1810	320	5.9
	2050	280	9.5		2190	310	7.2
	2400	290	11.8		2600	310	8.5
	2780	300	12.0		3020	330	8.4
	3080	300	13.2		3400	330	8.1
	3400	300	14.5		3760	330	9.2
	3720	310	15.6				
	4030	310	17.0				

Table 12.1 (Continued)

Gas Release No. 53 24 Aug 1956 1950C				Gas Release No. 54 24 Aug 1956 2150C			
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
948	0	18.0	44	949	0	20.0	51
940		22.7	41	918		20.8	42
900	460	21.0	35	904		20.0	35
850	941	17.2	42	900	459	19.8	35
825		15.1	45	850	950	17.3	43
800	1455	14.4	42	800	1406	14.6	50
774		13.8	38	772		13.6	32
700	2572	8.0	41	700	2583	8.7	42
686		7.0	42	600	3833	- 2.0	67
600	3822	- 1.4	63				

	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
Equipment Failure No Sounding				SFC	02	150	3.1
					380	160	12.5
					730	180	13.2
					1080	190	9.2
					1450	210	4.9
					1760	240	2.0
					2100	270	3.0
					2460	280	5.9
					2800	300	7.3
					3160	310	8.9
					3520	320	10.2
					3900	320	11.6

Table 12.1 (Continued)

Gas Release No. 55
25 Aug 1956 0055C

P (mb)	Z (m)	T (°C)	R.H. (%)
948	0	17.0	60
904		20.0	43
900	446	19.9	43
862		19.0	48
850	938	18.4	49
800	1456	15.0	52
756		11.9	56
710		9.2	41
700	2576	8.2	50
694		7.3	54
615		-0.5	70
600	3825	-2.1	70

Winds

	Z (m)	ddd (deg)	ff (m/sec)
SFC	02	150	8.2
	360	160	14.3
	700	189	12.0
	1030	200	10.2
	1350	210	9.2
	1680	220	6.0
	1980	230	4.0
	2280	240	4.6
	2600	250	5.8
	2900	260	5.7
	3230	270	7.0
	3600	290	7.7
	3020	300	7.4

Gas Release No. 56
25 Aug 1956 0250C

P (mb)	Z (m)	T (°C)	R.H. (%)
948	0	15.0	66
900	444	20.0	47
850	936	19.4	49
815		18.8	50
800	1457	17.2	51
761		13.3	56
726		10.7	44
700	2579	8.2	50
600	3829	-2.1	74

Winds

	Z (m)	ddd (deg)	ff (m/sec)
SFC	02	160	6.9
	260	170	11.8
	560	190	14.6
	1040	200	12.9
	1500	220	8.1
	1900	230	7.5
	2370	240	9.6
	2760	240	8.5
	3100	250	7.9
	3550	270	6.0
	3900	290	6.5

Table 12.1 (Continued)

Gas Release No. 57
25 Aug 1956 1720C

P (mb)	Z (m)	T (°C)	R.H. (%)
940	0	34.5	18
900	390	30.5	22
850	897	25.2	30
800	1425	19.9	39
784		18.0	42
738		15.0	23
700	2557	11.1	31
600	3819	0.4	50

Winds

	Z (m)	ddd (deg)	ff (m/sec)
SFC	02	200	9.8
	430	200	13.0
	870	200	13.0
	1250	210	14.0
	1640	210	17.8
	2200	220	17.5
	2650	230	15.8
	3000	240	14.0
	3300	250	10.2
	3620	200	9.0
	3950	270	8.0

Gas Release No. 58
25 Aug 1956 1920C

P (mb)	Z (m)	T (°C)	R.H. (%)
939	0	29.2	25
932		31.5	25
900	379	29.0	27
850	884	25.0	30
800	1410	20.6	33
762		17.1	36
744		15.5	23
700	2546	11.3	33
610		20.0	52
600	3812	1.0	55

Winds

	Z (m)	ddd (deg)	ff (m/sec)
SFC	02	180	2.1
	360	200	12.8
	730	200	14.5
	1110	210	14.6
	1500	220	15.0
	1900	220	15.0
	2280	240	11.9
	2630	240	11.1
	3020	250	10.4
	3350	250	8.5
	3750	260	8.9
	4030	260	9.5

Table 12.1 (Continued)

Gas Release No. 59, 25 Aug 1956 2220C				Gas Release No. 60, 26 Aug 1956 0020C			
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
939	0	25.5	38	938	0	25.5	35
913		31.0	23	907		29.1	26
900	379	30.2	24	900	375	29.0	35
855		27.4	24	860		27.4	25
850	880	26.9	25	850	882	26.6	35
800	1417	21.9	32	800	1413	22.0	28
716		12.9	45	784		20.6	29
700	2554	11.3	43	720		14.0	42
648		6.1	37	700	2552	11.8	47
600	3816	0.3	57	600	3818	0.4	72
	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	190	2.6	SFC	02	210	6.2
	400	200	15.8		440	220	22.5
	780	210	16.6		850	220	24.1
	1170	210	15.3		1200	220	19.2
	1570	220	15.0		1520	220	21.8
	1960	230	14.0		1850	220	14.2
	2350	240	11.3		2270	220	15.3
	2730	240	11.0		2750	220	11.2
	3160	240	10.8		3150	210	7.9
	3600	250	8.0		3490	210	8.1
	4000	260	6.6		3850	200	9.0

Table 12.1 (Continued)

Gas Release No. 61 27 Aug 1956 1050C				Gas Release No. 62 27 Aug 1956 1350C			
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
934	0	31.8	26	934	0	29.0	37
916		28.0	30	924		28.0	30
900	330	26.0	30	900	320	26.9	30
888		24.5	30	869		25.4	30
874		26.2	27	850	831	23.9	32
850	832	24.3	29	800	1357	19.6	38
800	1358	20.2	32	744		14.5	43
735		14.4	39	700	2488	10.3	54
700	2492	10.9	47	635		3.8	71
634		3.9	62	600	3749	0.2	75
600	3754	- 0.1	62				

	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	180	5.7	SFC	02	180	1.6
	317	260	9.7		280	210	6.5
	660	210	11.8		550	200	4.2
	990	220	8.0		800	200	3.0
	1200	220	7.0		1050	210	4.4
	1600	210	6.7		1250	220	5.8
	1900	210	8.4		1500	230	5.6
	2180	210	9.0		1730	220	5.9
	2400	220	9.2		1950	220	8.0
	2800	220	7.3		2200	220	9.5
	3070	230	7.5		2500	220	10.5
	3370	230	8.6		2800	230	12.0
	3650	230	9.7		3090	230	11.2
	3950	240	10.5		3350	230	11.7
					3700	230	12.0
					4000	220	10.5

Table 12.1 (Continued)

Gas Release No. 63 — 27 Aug 1956 1950C | Gas Release No. 64 — 27 Aug 1956 2220C

P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
931	0	24.5	47	932	0	19.6	67
923		30.7	34	921		29.1	40
900	302	29.0	34	900	309	29.6	30
853		25.4	34	894		29.7	28
850	807	25.1	34	858		27.3	28
800	1335	21.3	32	850	816	26.6	28
773		19.1	31	800	1346	22.0	29
700	2473	11.8	34	742		16.5	29
654		6.9	36	700	2484	11.9	35
600	3739	1.1	45	600	3747	6.0	41
	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	240	1.0	SFC	02	Calm	
	230	230	3.4		300	230	3.0
	480	220	5.0		720	230	4.6
	720	210	6.1		1080	230	6.6
	990	210	7.7		1460	230	8.0
	1290	210	6.0		1780	230	7.7
	1520	210	3.7		2110	240	5.8
	1810	210	3.5		2450	240	5.3
	2100	210	3.2		2790	240	4.4
	2370	220	3.5		3100	240	3.3
	2660	220	3.5		3490	240	4.6
	2940	230	2.4		3880	230	5.8
	3200	240	1.8				
	3450	260	2.5				
	3680	280	3.8				
	3970	280	4.0				

Table 12.1 (Continued)

Gas Release No. 65

29 Aug 1956 1920C

P (mb)	Z (m)	T (°C)	R.H. (%)
933	0	20.5	28
900	315	24.9	32
850	812	19.9	40
800	1331	15.8	50
786		14.4	52
700	2447	7.1	42
658		3.4	30
600	3686	- 1.2	24

Winds

	Z (m)	ddd (deg)	ff (m/sec)
SFC	02	180	3.1
	360	180	11.8
	700	180	13.6
	1080	190	13.0
	1440	200	11.0
	1830	220	10.6
	2200	240	11.0
	2530	250	11.5
	2900	260	11.2
	3220	260	12.2
	3580	270	12.2
	3900	270	10.0

Gas Release No. 66

29 Aug 1956 2120C

P (mb)	Z (m)	T (°C)	R.H. (%)
932	0	21.0	42
916		25.6	37
900	316	24.9	33
850	814	22.1	23
848		22.0	23
800	1336	18.0	28
750		13.4	34
700	2460	8.4	46
650		3.0	58
600	3711	- 2.0	56

Winds

	Z (m)	ddd (deg)	ff (m/sec)
SFC	02	180	3.6
	380	180	15.3
	750	190	17.4
	1100	200	14.5
	1420	220	14.1
	1800	220	13.9
	2150	230	10.2
	2460	250	9.1
	2750	250	9.6
	3130	260	12.0
	3520	260	14.1
	3920	270	15.0

Table 12.1 (Continued)

Gas Release No. 67 30 Aug 1956 0020C				Gas Release No. 68 30 Aug 1956 0220C			
P (mb)	Z (m)	T (°C)	R.H. (%)	P (mb)	Z (m)	T (°C)	R.H. (%)
932	0	21.0	47	931	0	21.0	45
911		24.6	37	916		24.2	40
900	304	23.8	40	900	295	23.6	37
876		21.9	45	850	791	21.3	30
850	801	21.1	34	830		20.4	27
830		20.5	24	800	1312	17.7	30
800	1323	17.8	30	700	2434	8.0	43
700	2444	7.9	46	672		5.2	47
686		6.4	49	635		2.2	43
600	3087	-2.4	59	600	3685	-1.8	50

	Winds				Winds		
	Z (m)	ddd (deg)	ff (m/sec)		Z (m)	ddd (deg)	ff (m/sec)
SFC	02	180	3.1	SFC	02	180	4.6
	380	190	16.0		400	210	14.6
	730	200	16.5		800	220	15.3
	1030	210	16.8		1160	220	12.8
	1320	220	17.3		1530	210	13.8
	1680	220	16.4		1920	210	12.7
	2000	220	13.6		2290	200	10.2
	2300	210	13.0		2640	200	9.7
	2620	210	11.0		3020	210	7.7
	2950	230	7.0		3380	240	6.4
	3230	260	5.0		3770	260	8.3
	3530	250	6.0				
	3900	260	7.3				

CHAPTER 13
AIRPLANE OBSERVATION DATA

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13.1 Introduction

The aircraft soundings taken at O'Neill, Nebraska at the times of the diffusion experiments are tabulated on the following pages. The data were recorded on an AFCRC Aerograph (Kollsman KS-4). In addition, altitude was read from a calibrated sensitive altimeter by an observer who also noted air conditions.

The pattern for the sounding which was regularly followed consisted of horizontal passes at constant airspeed and altitude along the north mile of the site section for altitudes up to 1000 ft. Then a box climb was made with observations on each side in level flight for 30 seconds. Unless clouds intervened, this was continued to 7000 ft above the site itself (9000 ft mean sea level indicated altitude). A spiral descent followed with one observation at either 1000 ft or 300 ft and a final traverse at an altitude similar to the initial run.

13.2 Tabulated Data

The first column, Z_p, gives the pressure altitude obtained from altimeter readings. The height of the lowest level was adjusted to match the pilot's intention to fly by his own calibrated altimeter and by visual reference to 50-foot instrument towers nearby. The other levels were corrected for scale and installation errors but can be as much as 25 feet too high due to a lack of up-to-date information on these errors and on the airport elevation.

The P_{mb} column is the pressure in millibars obtained by converting altimeter readings through use of a standard altitude table.

The T column is the temperature in °C read from a thermistor bead in a stagnation type probe on a boom on the wing. The value represents an average for the traverse when the trace was changeable and a value at the end of the traverse when a drift of temperature was noted. The value represents a free air temperature because it has been corrected for dynamic heating using a recovery factor of 0.85, found to be typical for the equipment used. The accuracy was of the order ± 0.2°C. Part of this spread was due to a modification to make the recorder more sensitive, which allowed the indicator to hunt through this range during the time of high ambient temperatures.

A column marked # refers to the behavior of the temperature trace. The code used is similar to the one used for pressure tendency reports. The first figure indicates the trend shown by the trace during the traverse, which lasted about 30 seconds. (The time taken to cover the one mile at 100 knots indicated air speed.) The second figure is the amount of change (plus or minus) indicated by an oscillating trace or the amount of temperature shift as indicated by the drifting of the trace. The significant values are given in the legend prefacing the table.

The RH column lists the estimated relative humidity obtained from a carbon-element electric hygrometer. The calibration curve used was that for a batch of pre-production elements. This was checked against apron values of a sling psychrometer before and after the flights. Comparison was made with the daily radiosonde upper air observations (lithium chloride elements) and the calibration curve was shifted to match the deviation of the overall average. As is customary, allowance was made for a small temperature shift; also in this RH column an allowance was made for the increase in probe pressure of 15 mb. The same element was used throughout because no deterioration nor regular shift could be proven in the field. The accuracy is of the order of 5 percent.

The VP column for vapor pressure in millibars and the DP column for dew point in °C are slide rule values. They are computed without allowance for the above mentioned probe-pressure effect. The gradient

values are considered good due to the fast response of the humidity element at these high temperatures. The accuracy of the absolute values is limited as noted above.

The TIME shown for each sounding is generally that of the time of gas release for convenient reference. The sounding actually started with the first pass; this first pass almost always corresponded with the start of the ground meteorological observations which was 5 minutes before gas release time. The first traverse followed the radiosonde balloon release by 5 minutes. The top level of a complete sounding was reached about 30 minutes and the final run about 45 minutes after the first traverse.

13.3 Remarks

Aircraft observations were not made for tests 23, 24, 31, 32, 33, and 34. At these times the aircraft was at Omaha for engine change and installation of additional instruments. An extra run of note was made and this is included as Field Test No. 48S.

The aircraft used was a standard USAF L-20, instrumented by the Research Airborne Engineering Branch of the Hanscom Air Force Base, Bedford, Mass. The crew consisted of Lt. George A. Sexton, Lt. E. E. Clark, pilots, and A/1c John I. Knutila, A/1c Joseph H. Driever, crew chiefs.

The thermistor used was modified for a response time of about three seconds and calibrated by James H. Meyer of the Lincoln Laboratory. The calibration used with the carbon element was provided by Alfred Spatola of the Cloud Physics Section of GRD.

Table 13.1 Aircraft Observations

LEGEND

Code for the # symbol

First Figure	Temperature Behavior
2	Unsteady or oscillating trace, may include a jump or a hump.
3	Drift to warmer temperature which is maintained.
8	Drift to colder temperature which is maintained.
dash	Smooth trace, no temperature change.

Second Figure	Temperature Oscillation	Temperature Drift
none	± 0.2°C	less than 0.5°C
2	± 0.3	0.5
4	± 0.5	1.0
5	± 0.6	1.2
6	± 0.8	1.5

Abbreviations used are those of the airways teletype code and contractions whose meaning is evident.

The observer's initials are listed because non-meteorological aides made frequent flights on which their observations are sparse. The pilots alternated in flying and no difference in techniques was noted.

Table 13.1 (Continued)

FIELD TEST NO. 1				3 JULY 1956			1100 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
50	943.5	21.0		97	24.4	20.7	
100	941.5	21.3		95	24.4	20.6	
180	939.0	21.1	22	91	23.0	19.7	
390	932.0	20.4	--	91	22.0	19.0	
610	924.0	19.2		94	21.2	18.4	
830	917.0	19.1		98	21.9	19.0	
1000	911.0	18.6		>100	21.4	18.6	
1520	893.5	17.3		>100	19.7	17.3	Ocnl bump lower levels
2015	876.0	16.3		>100	18.5	16.3	In clear
2400	865.0	15.1		>100	17.2	15.1	Base of clouds-in wisps
900	911.5	17.5		>100	20.0	17.5	
130	940.5	20.6		>100	24.3	20.6	
50	943.5	21.1		96	24.4	20.7	
50	943.5	21.2		95	24.4	20.7	Second pass Obsr P.H.

FIELD TEST NO. 2				3 JULY 1956			1500 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
50	943.0	23.5		82	24.0	20.4	
85	941.5	23.4		83	24.1	20.5	
160	939.0	23.4		83	24.1	20.5	Bump
430	931.0	22.6		85	23.2	19.9	
630	923.0	21.9		86	22.8	19.6	
840	916.0	21.1		85	21.6	18.8	
1025	909.5	20.7		89	22.0	19.0	
1515	893.5	19.8	82	92	21.2	18.5	
2025	876.5	18.2		96	20.4	17.8	Steady
2535	860.0	17.0		99	19.4	17.0	Ocnl bump
3020	844.5	15.7	--	100	17.8	15.7	In clds
3545	828.0	14.4		>100	16.4	14.4	Thru hole in clds
4065	812.0	13.6	82	>100	15.6	13.6	Thru thin clds
5040	782.5	11.7		>100	13.7	11.7	Between clds
							First bump about 1200'
1000	910.5	18.8	32	>100	21.7	18.8	Descending 500'/minute
60	943.0	21.4	22	100	25.4	21.4	Abrupt descent to here
60	943.0	22.3		94	25.4	21.4	Traverse after 30 seconds Obsr P.H.

See Legend — No. 1 & 2

Table 13.1 (Continued)

FIELD TEST NO. 3				5 JULY 1956			1100 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
		22.4		95	25.7	21.5	
220	940.0	26.0		58	19.7	17.3	
160	942.0	25.8		60	20.2	17.7	
390	934.5	25.2	21	60	19.6	17.2	
600	927.0	24.5		63	19.7	17.2	
840	919.0	24.0	62	65	19.7	17.2	
1010	913.0	24.3		66	20.0	17.6	
1520	896.5	23.0	82	67	19.1	16.8	
2010	880.0	21.9	82	67	17.9	15.7	
2505	864.0	20.6		72	17.6	15.5	
3025	847.5	19.1		67	15.0	13.0	
3505	832.5	18.0		65	13.8	11.7	
4045	815.5	16.5		60	11.5	9.0	
5025	786.0	14.7		64	11.0	8.4	
220	940.0	23.9	32	73	21.8	18.9	Obsr P.H.

FIELD TEST NO. 4				6 JULY 1956			0100 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
		20.6		92	21.8	18.9	Equip Osc ±0.2°C per 10 sec-taxiing
180	941.0	25.9	--	60	20.2	17.7	Tmp max on Sdg
405	933.5	26.1	--	60	20.4	17.8	
615	926.0	25.4	--	60	19.6	17.2	
820	919.5	24.8	21	60	19.0	16.7	
1010	913.0	24.4	22	59	18.5	17.3	
1600	896.5	23.4		60	17.4	15.3	
1995	880.0	22.0		59	15.8	13.8	
2495	860.5	20.6		69	16.9	14.9	
3000	848.0	19.2		75	16.8	14.8	Pireps slight turbc
3505	832.0	17.8		74	15.2	13.3	above 3000'
3990	817.0	16.6		71	13.6	11.5	
5025	785.5	14.4		58	9.8	6.7	
190	941.0	23.6	44	82	23.8	20.3	Pireps slight turbc Sharp 2° inversion Obsr J.D.

See Legend

No. 3 & 4

Table 13.1 (Continued)

FIELD TEST NO. 5				6 JULY 1956			1400 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
60	944.0	29.4		47	19.2	16.9	
75	943.5	29.4		47	19.3	17.0	Ocnl gust all levels
170	940.0	29.3		47	19.2	16.9	
375	933.0	28.5	22	48	18.8	16.5	
630	924.5	27.8		49	18.6	16.3	
820	918.0	27.2	22	50	18.2	16.1	Bumpy below
900	912.0	26.2	22	53	18.3	16.1	
1500	895.0	25.3	82	52	17.0	1.50	One gust
2000	878.5	23.8	82	54	16.3	14.3	
2505	862.5	22.3	22	56	15.5	13.6	
3005	846.5	21.2	22	49	12.6	10.4	
3495	831.0	20.1	22	49	11.5	9.1	
4030	814.5	18.2		49	10.9	8.2	
5045	784.0	17.4		52	10.4	7.6	
300	935.5	26.5	32	63	22.1	19.1	
35	945.0	28.5	32	52	20.0	17.5	Obsr J.D.

FIELD TEST NO. 6				6 JULY 1956			1700 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
50	942	30.3	22	43	18.5	17.3	
75	941	30.7	--	46	20.3	17.8	
165	938	30.2		46	19.8	17.3	
375	930.5	29.0		46	18.4	16.2	
635	922	29.0	82	46	18.6	16.4	
805	916	28.3		46	17.8	15.7	
1005	909.5	27.8		48	18.1	15.9	
1515	892.5	26.7		46	16.3	14.3	
1995	876.5	25.3	82	50	16.4	14.4	
2500	860.5	23.3	82	54	15.6	13.6	
3020	843.5	22.8		50	14.2	12.2	
3560	827.0	21.2		46	11.5	9.1	
4000	813.0	20.5		42	10.3	7.4	
5010	783.0	18.3		40	10.4	7.4	
275	934.0	27.7	33	54	20.3	17.7	
65	941.0	30.0		47	20.0	17.5	Obsr J.D.

See Legend

No. 5 & 6

Table 13.1 (Continued)

FIELD TEST NO. 7 — 10 JULY 1956 — 1400 CST

Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
50	944.5	30.1	22	38	16.3	14.3	
90	943.0	29.6		39	16.3	14.3	Obrep sounding
180	940.0	29.2	22	40	16.0	14.1	Rough aloft
390	933.0	28.6		39	15.3	13.4	
590	926.0	27.8		41	15.5	13.5	
820	916.0	27.2	22	42	15.4	13.4	
1000	912.0	26.9		42	14.8	12.8	
1520	894.5	25.3		45	14.4	12.4	
2015	878.5	23.8	22	47	13.8	11.8	
2505	862.5	21.8		50	13.0	10.9	
3005	846.5	20.5	82	52	12.6	10.4	
3515	830.5	18.9	82	56	12.4	10.2	
4035	814.5	17.3		59	11.9	9.6	
5045	784.0	14.6	82	62	10.4	7.6	
6085	753.5	12.3	82	66	9.6	6.4	
7090	725.0	9.8		68	8.4	4.5	Turbulence noted
200	936.0	26.4	32	45	15.6	13.6	
90	943.0	29.1	32	41	17.0	15.0	Obsr J.D.

FIELD TEST NO. 8 — 10 JULY 1956 — 1400 CST

Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
50	943.0	30.5	22	39	17.1	15.0	Ocnl bumps and drafts
90	941.5	30.1	23	39	16.7	14.7	Drafts
180	938.5	29.8	23	41	17.4	15.2	
395	931.0	29.3	82	42	17.3	15.2	Ocnl bumps
640	922.5	28.2		43	16.4	14.4	
830	916.0	27.8		42	15.8	13.8	Bumpy
1000	910.5	27.0		44	15.5	13.6	
1500	894.0	25.7		45	14.7	12.7	
2015	877.0	23.8		46	14.2	12.1	Ocnl yaw
2525	860.5	22.1	22	50	13.4	11.3	
3035	844.0	20.5		54	13.4	11.3	Smoother
3546	828.0	19.0		59	13.2	11.0	Bumps
4045	813.0	17.6		59	13.0	10.8	Yawing
5065	782.0	14.6		68	11.6	9.1	Smooth, some cloud bases
6075	752.5	11.9		73	10.3	7.4	Cloud bases these altitudes
7090	723.5	9.3		79	9.5	6.2	Wallowy
320	937.0	29.1	32	39	15.8	13.8	Obsr P.H.
95	941.5	30.7	22	39	17.3	15.2	

See Legend

No. 7 & 8

Table 13.1 (Continued)

FIELD TEST NO. 9				11 JULY 1956			1000 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
60	939.0	25.9	23	62	21.2	18.4	Bumpy
100	937.5	25.6	23	62	20.8	18.2	
165	935.0	25.3	22	65	21.2	18.4	
395	927.5	24.7	22	67	21.0	18.3	Drafts
610	920.0	23.9	22	70	21.1	18.4	
825	912.5	23.1	22	72	20.4	17.8	
990	907.0	23.2		72	19.3	16.9	Bumps lift
1490	890.5	21.1	23	73	18.4	16.2	
2025	875.0	21.4	16	73	18.8	16.5	Slow osc
2515	857.0	22.4	23	66	18.3	16.1	Steady
3015	841.5	21.5	22	68	17.6	15.5	Hazy vsb 8 to 10
3495	826.5	20.9		65	16.4	14.4	
4035	809.5	20.6		54	13.2	11.1	
5025	780.0	18.6		50	11.0	8.4	
6035	750.5	16.1		47	8.7	5.0	Ac clds 5000' above
7060	721.5	13.1		49	7.4	2.6	Hazy
280	931.5	25.2	34	70	22.7	19.5	
55	939.0	26.6	23	60	21.3	18.5	Obsr P.H.

FIELD TEST NO. 10				11 JULY 1956			1200 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
45	939.0	28.4	22	55	21.5	18.7	
90	937.5	28.2	23	56	21.8	18.8	
185	934.0	27.8	22	56	21.2	18.5	
405	926.5	26.9	22	60	21.7	18.8	
635	919.0	26.3	23	63	21.8	18.8	
820	912.5	25.4		66	21.7	18.8	
990	907.0	25.5	22	66	21.8	18.9	
1490	890.5	23.6	22	70	20.8	18.2	
2005	873.5	21.9	22	72	19.3	17.0	Pireps rough below
25[illegible]	857.5	20.4	22	74	18.0	15.8	Relatively smooth above
3015	84[illegible]	19.7	14	70	16.3	14.3	
3515	825.5	20.3	32	62	15.0	13.0	
4015	810.0	19.7	22	54	12.5	10.3	
5015	780.0	18.1		54	11.4	8.8	
6025	750.5	15.6	22	53	9.5	6.3	
7040	722.0	12.9	22	60	9.1	5.6	
290	930.5	27.7	22	58	21.9	19.0	
60	938.5	29.0	32	55	22.3	19.2	Obsr J.D.

See Legend

No. 9 & 10

Table 13.1 (Continued)

FIELD TEST NO. 11				14 JULY 1956			0800 CST
Z_p, (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
40	942.5	23.5	23	83	24.2	20.6	Bump
90	941.0	32.4	23	88	24.2	20.5	
190	937.5	23.1	22	83	23.7	20.2	Drafts
380	931.0	22.4	22	83	22.7	19.5	
640	922.0	21.8	22	85	22.4	19.3	
840	915.5	22.4	23	84	23.0	19.8	Bumps
1040	908.5	23.1	23	76	21.8	18.8	Steadier
1520	892.5	22.8	32	82	22.8	19.6	
2010	876.5	23.6		50	14.8	12.8	Smooth
2495	861.0	22.6	22	55	15.2	13.2	
3025	844.0	22.4		42	11.5	9.0	
3495	829.0	22.2		42	11.4	8.8	
4035	812.5	20.8		39	9.7	6.5	Oscillation
5035	782.5	17.7		46	9.4	6.2	Smooth
6035	753.0	15.5		46	8.1	4.0	
7080	723.5	12.5		43	6.3	0.4	Oscillation bumps at 1300'
200	934.0	23.8	32	85	25.2	21.3	
50	942.5	23.9	83	80	23.8	20.3	Obsr P.H.

FIELD TEST NO. 12				14 JULY 1956			1000 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
75	941.0	27.8	22	86	24.8	21.0	
160	939.5	27.2	22	66	24.3	20.6	Bumpy
360	931.5	26.7	22	70	24.8	21.0	Lifts begin
620	922.5	25.9	22	73	24.7	20.9	
800	916.5	25.4	22	77	25.4	21.4	Gusts at end
1000	909.5	24.9	22	78	24.8	21.0	
1510	892.5	24.4	24	72	22.2	19.1	Occasional bumps
2005	876.5	24.6	24	52	16.4	14.4	Smooth
2485	861.0	23.9	22	50	14.8	12.9	
3015	844.0	23.1	22	39	11.1	8.5	Steady
3495	829.0	21.9	--	38	10.0	7.0	
4030	812.5	21.1		35	8.8	5.0	
5035	782.6	18.4		39	8.4	4.4	Yaw
6035	753.0	16.1		40	7.3	2.4	
7040	724.5	13.0		48	7.1	2.1	Steady Bumps at 1900
280	934.0	27.6	34	44	16.4	14.4	
70	941.5	29.2	24	50	20.8	18.2	Bump Obsr P.H.

See Legend

No. 11 & 12

Table 13.1 (Continued)

FIELD TEST NO. 13				22 JULY 1956			2000 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
45	947.0	23.3	82	62	18.1	16.0	SC vesperalis 9000'
60	945.5	22.8		65	18.2	16.0	Sun low at the horizon
180	942.5	23.1	--	59	17.0	15.0	Smooth
400	935.0	23.0		59	16.9	14.9	
620	927.0	21.8	32	62	16.6	14.6	Very smooth
830	920.0	21.2		65	16.5	14.5	One lift; sunset
1000	914.5	20.9		67	16.9	14.9	
1505	897.5	19.6	82	71	16.5	14.5	
2000	881.0	18.0		72	15.0	13.1	Very light turbc
2500	865.0	16.6		72	13.6	11.8	Smooth
3020	848.9	15.1		73	12.8	10.6	
3505	833.0	13.7		77	12.2	10.0	R H Osc
4045	816.5	12.6		90	13.3	11.2	Smooth
5030	786.5	10.4		97	12.4	10.1	
6070	756.0	8.1		100	11.3	8.1	Cloud base 5800
7080	727.0	6.3		96	9.4	6.0	Top about 6500 vrbl
285	938.5	22.3		62	17.0	15.0	
180	942.5	22.6	22	60	16.8	14.8	Obsr P.H.

FIELD TEST NO. 14				22 JULY 1956			2200 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
170	943.5	21.7	22	57	15.0	13.0	
355	937.0	22.4		54	14.8	12.9	
600	928.5	21.8		60	15.8	13.8	
820	921.0	21.4	22	59	15.2	13.2	
985	915.5	21.0		56	14.3	12.3	
1500	898.5	19.6		62	14.4	12.4	
1985	882.5	18.1		73	15.4	13.4	
2485	866.0	16.7	22	81	15.6	13.6	Light turbc
2985	850.0	15.0		83	14.4	12.4	Light turbc
3495	834.0	14.4		90	15.0	13.0	
4005	818.0	13.1		93	15.0	13.1	
4990	788.0	11.3		82	11.2	8.7	Ocnl bump above
6025	758.0	9.4		75	9.0	5.4	
7020	720.5	6.9		87	8.8	5.1	
260	940.0	22.3		54	14.8	12.8	
170	943.5	22.3	22	53	14.5	12.5	Obsr J.D.

See Legend

No. 13 & 14

Table 13.1 (Continued)

FIELD TEST NO. 15				23 JULY 1956			0800 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
50	947.0	19.4	22	84	19.2	16.8	
75	942.5	19.2	22	83	18.8	16.5	
185	942.0	19.0		84	18.8	16.5	
305	935.0	18.9		84	18.6	16.4	Occasional H turbc
635	926.5	20.1	22	80	19.1	16.8	
845	919.5	20.3		81	19.6	17.2	
1005	914.0	20.1		82	19.6	17.2	Hazy level not sharp
1525	897.0	20.0		65	15.8	13.6	
2020	880.5	18.8		69	15.2	13.2	
2500	865.0	17.1	--	78	15.5	13.5	
3030	848.0	15.9		84	15.3	13.3	
3520	832.5	15.2		59	10.4	7.5	Above smoky layer
4050	816.0	13.9	--	47	7.5	2.8	
5040	786.0	11.7		42	5.9	-0.4	
6060	756.0	9.4		36	4.3	-4.1	
7085	727.0	7.8		32	3.5	-6.5	Few Ac on horizon
285	938.5	20.4	32	84	20.3	17.8	A few little bumps
60	946.5	21.3		75	19.3	14.9	Obsr P.H.

FIELD TEST NO. 16				23 JULY 1956			1000 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
50	946.5	24.4	24	62	19.4	17.0	
100	944.5	24.4	24	63	19.2	16.9	
190	938.0	24.1	22	62	18.8	16.6	
400	934.0	23.3	22	65	18.8	16.6	
610	927.0	22.6	82	64	17.8	15.7	
830	919.5	21.9	22	72	19.3	17.0	
1010	913.5	21.5	22	76	19.7	17.3	Obreps bumpy to here
1500	897.0	20.3	22	73	17.6	15.5	
2005	880.5	18.8	22	74	16.2	14.2	
2495	864.5	17.9	--	76	15.5	13.5	
3015	848.0	16.0		76	14.6	12.5	
3495	833.0	14.8	22	71	12.2	9.9	
4035	816.0	14.7		42	7.3	2.2	A light layer of scattered clouds
5025	786.0	12.4		38	5.5	1.2	
6045	756.0	10.3		54	6.9	1.8	
7050	727.0	8.0		74	8.1	3.9	
300	937.5	24.4	32	58	18.1	16.9	
50	946.0	25.8	32	50	16.7	14.7	Obsr J.D.

See Legend

No. 15 & 16

Table 13.1 (Continued)

FIELD TEST NO. 17				23 JULY 1956			2000 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
50	941.0	29.0		37	14.6	12.6	
80	940.0	28.8		37	14.4	12.4	
180	936.5	29.3	--	35	14.4	12.4	
390	929.0	29.5	22	33	13.7	11.6	
620	921.5	29.4		29	12.0	9.6	
820	914.5	28.6	22	31	12.2	10.0	
990	909.5	28.2		33	10.7	10.5	
1480	892.5	26.9	22	32	11.9	9.5	
2005	875.5	25.5		34	11.3	8.8	Pireps temp 72°F
2505	859.0	24.8	12	36	11.2	8.7	
2985	844.0	23.2		38	10.8	8.2	
3505	827.5	21.7		39	10.2	7.3	
3995	812.5	20.3		44	10.4	7.6	
5015	781.5	17.5		49	9.9	6.8	
6005	752.5	14.9		52	8.9	5.4	
7040	723.5	11.8		60	8.4	4.5	Very lgt turbc Pireps 53°F
280	933.0	28.4	--	35	13.7	11.6	
180	936.5	28.4	22	36	14.1	12.1	Obsr J.D.

FIELD TEST NO. 18				23 JULY 1956			2200 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
160	939.0	27.6	32	39	14.3	12.2	(St Cu drifted out,
345	932.5	27.9	22	35	13.3	11.2	wind varied with
605	923.5	27.9	32	36	13.4	11.2	cloud cover)
815	916.5	27.7	82	33	12.4	10.2	
985	911.0	27.2	22	33	12.1	9.8	
1475	894.5	26.4		32	11.1	8.6	Fst bump
1980	878.0	25.6	--	36	11.7	9.3	Lgt turbc continuous
2490	861.5	24.4		39	11.8	9.4	Bumps not gusts
2970	846.0	23.4	22	39	11.3	8.8	(Pireps alt changes rather than airspeed changes noted)
3510	829.0	21.8	82	42	11.1	8.6	
4010	813.5	20.3	22	46	10.9	8.2	Bumps small but pitching
5010	783.5	17.4	22	54	10.8	8.2	Choppy
6010	754.0	14.6		61	10.3	7.4	Wallowy
7030	725.5	11.6		65	9.0	5.5	Up & down drafts
255	935.5	26.4	62	42	14.4	12.4	Smooth below about 1200'
155	939.0	26.7		43	15.0	13.1	Obsr P.H.

See Legend

No. 17 & 18

Table 13.1 (Continued)

FIELD TEST NO. 19				25 JULY 1956			1100 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
50	943.0	27.0	23	40	14.2	12.1	Cirrus clouds sun out
75	942.0	26.7	22	40	14.0	11.9	Bouncy
175	939.0	26.4	22	41	14.0	12.0	
390	931.5	25.7	22	42	13.9	11.9	Bumps
620	923.5	25.2		43	13.8	11.8	
850	916.0	24.5	22	45	14.0	12.0	Drafts
1000	908.5	24.0	22	45	13.5	11.4	
1500	894.0	22.4	23	50	13.5	11.4	Bouncing
2015	877.0	21.0	22	53	13.4	11.4	
2505	861.0	20.5	24	35	8.4	4.5	Less drafty
3025	844.5	20.3	22	25	6.0	-0.3	R H data doubtful this test, response sluggish
3515	929.5	20.0	22	25	5.9	-0.5	
4035	813.5	20.0	22	25	5.9	-0.5	
5035	783.0	18.2	12	28	6.0	-0.3	Smooth
6045	753.5	16.2		31	5.7	-0.4	
7080	724.0	13.5		36	5.7	0.9	Slow osc
							Bumps at 2500'
300	934.5	26.8	22	43	15.1	13.1	Lift at 800
100	941.5	28.4	22	40	15.4	13.4	Big bump Obsr P.H.

FIELD TEST NO. 20				25 JULY 1956			1300 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
		32.8					Humidity element
75	930.5	29.4	23	31	12.7	10.6	inspected
175	936.0	29.3	23	29	11.8	9.4	
375	929.0	28.6	22	31	12.1	9.6	
595	921.5	27.7	22	33	12.4	10.1	
805	914.5	27.0	22	36	12.9	10.6	
1015	907.5	26.2	22	36	12.4	10.2	
1505	891.0	25.1	22	35	11.3	8.6	
2000	875.0	23.2		35	10.2	7.2	
2480	859.5	21.8	22	43	11.1	8.5	
3020	842.5	21.6	26	28	7.4	2.6	
3490	827.5	22.0	24	25	6.6	1.0	
4010	811.5	21.4	23	25	6.8	0.6	
5020	781.0	19.4	22	28	6.4	0.6	
6030	751.5	17.0		28	5.8	1.1	
7045	723.0	13.8		36	5.8	0.6	
							Turbc below 3000 ft
275	932.5	30.0	33	25	10.5	7.7	
85	939.0	30.5	82	24	10.8	8.0	Obsr J.D.

See Legend

NO. 19 & 20

Table 13.1 (Continued)

FIELD TEST NO. 21				26 JULY 1956			2100 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
175	932.0						
390	924.5						
600	917.5						Rough
850	909.0	28.6	32	34	13.3	11.2	Ltng to N
1020	903.5	29.5	22	32	13.2	11.1	Smooth suddenly
1490	888.0	28.8	32	29	11.5	9.0	
2015	870.5	27.7		28	10.4	7.6	
2495	855.0	27.6		24	8.9	5.3	Steady
2995	839.5	26.9		25	8.9	5.3	
3495	824.0	25.4		26	8.5	4.6	Temp min sharp about 3800'
3995	808.0	24.4		29	8.8	5.2	Smooth
5020	778.5	21.2	24	31	7.8	3.4	Bumpy then steady
6045	749.0	18.1		35	7.3	2.4	Hvy ltng to N Smooth
7070	719.5	16.5	32	27	5.1	-2.2	-1.5°C tmp blip on climb Equipment looks OK
295	928.0	28.7		31	12.2	10.0	Bumps at 800'
180	932.0	28.7		30	11.8	9.4	Obsr P.H.

FIELD TEST NO. 22				26 JULY 1956			0000 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
180	931.0	27.6		37	13.7	11.6	Pireps strong winds aloft
400	923.5	27.1	22	37	13.3	11.1	Bumpy
640	915.5	26.6	35	37	12.9	10.8	
850	908.0	26.4	24	38	13.6	10.9	
1030	902.0	26.2	25	38	12.9	10.6	
1500	886.5	27.5	84	34	12.5	10.2	
2025	869.5	27.4		29	10.6	7.8	
2515	853.5	27.5	22	25	9.2	5.8	
3035	837.5	27.0	22	24	8.6	4.8	
3515	822.5	25.0	22	23	7.7	3.2	Very lgt turbc
4035	806.5	24.9		23	7.3	2.4	Lgt turbc at 4500'
5025	776.5	21.6		23	5.9	-0.4	Smooth at 5500'
6045	747.0	19.5	22	23	5.2	1.9	
7080	719.0	16.6	22	23	4.4	-4.0	Lt turbc at 5600' descent into haze at 4400'
280	927.5	26.6	--	36	12.6	10.4	Out haze at 1400'
200	930.0	26.9		36	12.8	10.6	Bumps at 300' Obsr J.D.

See Legend

No. 21 & 22

Table 13.1 (Continued)

FIELD TEST NO. 25				1 AUGUST 1956			1300 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
50	944.0	22.6	22	96	26.5	22.0	Bouncy
100	942.5	22.6	22	[illegible]	25.8	21.6	
190	939.5	22.0	22	96	25.5	21.4	
410	932.0	21.4	22	94	24.3	20.6	Drafts and acceleration
630	924.5	20.7		>100	24.7	20.7	R H sluggish
845	917.0	20.0		>100	24.4	20.0	Bumpy
1035	910.5	19.5		>100	23.7	19.5	R H sluggish
1510	895.0	8.2		>100	22.[illegible]	12.2	Bumpy at base about 1600' In clouds at 1750' and drafts
1000	912.0	19.4		>100	23.2	19.4	Bumpy
50	944.0	22.9	32	96	27.0	22.4	Est 60 ft by the tower 40 ft indicated Obsr P.H.

FIELD TEST NO. 26				2 AUGUST 1956			1200 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
50	940.0	27.3	24	66	24.2	20.5	
60	939.0	26.9	23	68	24.4	20.6	
190	935.5	26.9	23	67	24.0	20.4	Drafts
395	92[illegible]	26.3	23	72	24.8	21.0	Bumpy
630	920.0	25.6	22	75	24.9	21.0	
830	913.5	25.6	22	71	23.7	20.2	Bumpy
1010	907.5	24.4	22	78	23.9	20.4	
1490	891.5	23.0	82	82	23.2	19.9	
2005	874.5	21.2		92	23.4	20.0	Turbc
2460	860.0	[illegible]	14	91	22.0	19.1	Wobbles no drafts
2985	845.0	18.6	66	88	[illegible]	16.7	
3495	827.0	18.6	24	81	17.6	15.4	Sctd cld bases below
4035	810.5	18.4		63	13.6	11.5	Passing cld bases at 3700'
5025	781.0	16.2	83	82	15.3	13.3	Climb in clear
6045	751.0	14.0	--	78	13.7	10.6	
7050	722.5	11.8		95	12.9	9.6	In clds 4500 to 4800 ft on descent
1020	907.0	24.8	34	73	23.1	19.8	Bases est 3500 ft Bumps
295	931.5	27.6	33	57	21.4	18.6	Bumps
50	940.0	28.4	22	54	21.2	18.4	Low 50' pass Obsr P.H.

See Legend

No. 25 & 26

Table 13.1 (Continued)

FIELD TEST NO. 27				2 AUGUST 1956			1400 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
50	939.5	29.9	24	50	21.2	18.5	Bumpy
80	938.5	30.1	23	49	21.0	18.3	Drafts already
175	935.5	29.6	23	50	20.8	18.2	
390	927.5	29.2	63	50	20.5	17.8	Drafts
615	920.0	27.9	23	52	20.0	17.5	Occasional gusts
830	913.0	27.5	22	54	20.2	17.6	Ups & Downs
1020	906.5	26.9	22	56	20.4	17.8	Negative G acceleration
1500	890.5	25.4		67	22.0	19.0	Bumpy
2015	873.5	23.6		79	23.2	19.0	
2495	858.0	22.1		80	21.4	18.6	Now under clouds, bumpy
3025	841.5	20.6		84	20.6	18.0	
3515	826.0	19.0	22	93	20.7	18.0	Wobbly
4025	810.5	17.6		98	19.9	17.4	Base of clouds just above
5035	780.0	16.4	22	72	13.7	11.6	Cloud haze at 4800 ft
6045	750.5	14.6		75	12.6	10.4	Cld tops 5000-5500 ft
7065	721.5	11.7		81	11.3	8.7	Deck Ac est 1000' above
							Lgt moisture content in clds
290	931.0	30.1	22	50	21.6	18.7	Bumps at 300'
70	938.5	31.0	23	49	22.0	19.0	Bumpy Obsr P.H.

FIELD TEST NO. 28				3 AUGUST 1956			0000 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
		28.2					
165	934.5	26.4	22	72	25.0	21.1	Bumpy
385	927.0	26.5	22	70	24.6	20.8	Lgt rain bumps
605	919.5	26.4	22	70	24.6	20.8	Humidity sluggish
835	911.5	26.5	22	65	22.8	19.6	
1005	900.0	26.9		61	20.3	17.7	
1505	889.5	25.4	22	52	18.2	16.0	
1980	873.5	25.2		51	16.7	14.7	Ltng to N
2490	857.5	23.8		52	15.5	13.6	Ocnl bump
2980	841.5	23.8	22	51	15.4	13.4	Smooth
3510	825.0	23.0		49	13.7	11.6	
4030	809.0	21.4		50	12.8	10.6	
5040	779.0	19.1		54	12.1	9.8	Smooth
6050	749.5	15.6		76	13.6	11.6	Strong S Wind
7025	722.0	12.8		82	12.3	10.0	Freq ltng N
							-3°C at about 700' due R
1475	890.5	26.4		50	17.2	15.1	High pass account wea
175	934.0	27.4	22	55	20.4	17.8	Obsr P.H.

See Legend

No. 27 & 28

Table 13.1 (Continued)

FIELD TEST NO. 29			3 AUGUST 1956			[illegible] CST	
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
165	935.0	27.4	22	50	18.4	16.2	
365	928.0	26.8	22	50	17.[illegible]	15.6	
595	920.0	26.5	12	50	[illegible]	15.5	Gusts
795	913.5	25.9		49	16.5	14.5	Accelerations felt
995	906.5	26.0	22	50	16.7	14.7	
1475	890.5	26.2		45	15.3	13.4	Smoother [illegible]
2000	873.5	25.8	32	45	15.0	13.0	
2470	858.5	24.2		45	13.8	11.8	Smooth
3010	841.0	22.7		46	12.6	10.4	
3490	826.0	21.[illegible]	22	47	12.1	9.8	
4000	810.5	19.8		49	11.3	8.8	Rain encountered approaching [illegible]
965	907.5	26.2	32	48	10.3	14.3	Bumps at 700 No low pass Obsr P.H.

FIELD TEST NO. 30			3 AUGUST 1956			1300 CST	
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
75	938.0	31.8	23	42	19.8	17.3	Rough Obsr P.H.
175	935.0	31.4	23	43	19.7	17.2	Bumpy
375	928.0	30.8	22	45	20.2	17.7	Drafts
625	919.5	30.0	23	46	19.5	17.1	Drafts
850	912.0	29.4	--	50	20.7	18.0	Drafts
995	907.0	28.6	63	47	18.5	16.2	
1465	891.5	27.4	12	50	18.4	16.2	
2030	873.0	25.7	22	54	18.2	16.0	Occasional light bumps
2505	857.5	23.9	22	61	18.3	16.1	Drafts
3020	841.0	22.5	12	64	17.6	16.7	
3525	825.5	20.7		72	17.8	15.7	Wallowy
4016	810.5	19.0	22	76	17.0	15.0	
5060	779.5	16.4	--	83	15.7	13.7	Occasional bump
6050	750.0	14.8		64	11.0	8.4	(Approaching base level at
7105	720.0	11.9	32	76	10.8	8.1	5800) Edge of FrCu Base clds 6000' tops 7000'
[illegible]	907.5	26.6	62	47	18.2	1[illegible].0	No level pass account of boom oscillation

See Legend

No. 29 & 30

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Table 13.1 (Continued)

FIELD TEST NO. 37				12 AUGUST 1956			0300 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
		19.1					
165	936.5	21.1	32	84	21.3	18.5	Bumps ltng N & NE
385	929.0	22.4		78	21.6	18.7	
605	921.5	22.9		74	20.8	18.1	
810	914.5	22.9		72	20.4	17.8	
975	909.0	23.0		68	16.7	14.7	
1475	892.5	22.6	--	54	15.0	13.0	
2000	875.0	21.5	--	53	13.8	11.9	Lgt trubc pirep
2510	859.5	20.6		53	13.1	11.0	
2995	843.0	19.8		53	13.5	10.2	
3470	828.5	18.4		52	11.2	8.7	
4000	812.0	17.[illegible]		53	10.7	9.0	Very light turbc
5010	781.5	16.2		76	10.2	7.3	
6020	7[illegible]	14.2		74	12.1	9.8	
7040	7[illegible]	11.[illegible]		83	11.2	8.7	Ltng E Light turbc at 3500
975	[illegible]	22.1	--	77	20.9	18.2	
155	937.0	21.2	12	84	21.5	18.6	Bumpy Obsr P.H.

FIELD TEST NO. 38				12 AUGUST 1956			0500 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
		21.2					
170	936.0	21.1		85	21.5	19.0	Pireps sfc the same
380	929.0	22.5	33	78	21.5	18.6	
630	920.[illegible]	[illegible]	22	[illegible]	[illegible]	17.0	
830	914.0	23.5		[illegible]	[illegible]	15.5	
1010	907.5	23.6		40	14.3	12.3	
1510	891.0	24.0		42	12.6	10.4	
2015	874.5	22.4		48	13.2	11.1	
2495	859.0	21.7		44	11.8	9.4	
3005	843.0	20.0	--	47	10.9	8.2	
3515	827.0	18.6		50	10.7	8.0	
4015	811.5	17.8		59	12.3	10.0	Light turbc
5025	781.0	16.5		51	9.7	6.5	
6035	751.5	13.9		87	14.0	12.0	RH jump about 5200'
7040	723.5	11.2		80	12.0	9.7	Pireps lgt turbc RH drop about 5600'
990	908.5	22.5		63	17.4	15.3	
30	941.0	20.5	82	80	21.8	18.9	Obsr J.D.

See Legend

No. 37 & 38

Table 13.1 (Continued)

FIELD TEST NO. 39				13 AUGUST 1956			2200 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
190	941.5	26.2	12	44	15.3	13.4	Ocnl bump at 300'
420	933.5	27.1	63	43	15.8	13.8	
620	927.0	27.3		42	15.3	13.3	Smooth
850	919.0	27.3	22	40	14.4	12.4	One bump, ocnl draft
1060	912.0	26.4	22	40	13.8	11.8	
1525	896.5	25.7	--	39	12.8	10.6	
2045	879.0	24.3		39	11.8	9.4	Smooth
2515	864.0	23.0	22	39	11.9	8.4	
3035	847.5	21.8		42	11.6	8.3	
3525	832.0	20.0		47	11.0	8.3	
4040	816.0	18.3		50	10.6	7.9	Pireps added power needed
5040	785.5	16.3	62	55	10.3	7.4	Several bumps, lgt turbc
6070	755.5	14.3		67	11.1	6.5	Some bases at 6500, turbc
7090	726.5	11.3		72	9.8	6.7	Clds above, turbc, drafts
1000	914.0	26.4	--	40	13.7	11.6	Bumps at 500
205	941.0	25.0		32	14.2	12.2	Turbc noted thruout Obsr P.H.

FIELD TEST NO. 40				14 AUGUST 1956			0030 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
150	942.5	26.4	62	44	15.1	13.1	
385	934.5	27.2	22	44	15.8	13.8	No turbc noted
610	926.5	27.0	22	43	16.2	14.2	
810	919.5	27.3	22	43	15.6	13.7	Pireps strong wind
1000	913.5	27.3	22	43	15.6	13.7	
1510	896.5	25.5		45	14.8	12.8	
2010	880.0	24.3		45	13.8	11.7	Pireps less power rqrd
2500	864.0	22.7		47	13.2	11.1	
3000	848.0	21.2		47	11.8	9.4	Pireps ditto
3490	832.5	20.0		48	11.2	8.7	
4000	817.0	18.4		48	10.2	7.2	
5030	785.5	16.3		63	11.8	9.4	Ocnl drafts
6040	756.0	14.1		66	10.8	8.1	Lgt turbc 5600 ft
7070	726.5	11.3		71	9.6	6.4	Bumps, wallowy
980	914.0	26.4	32	47	16.4	14.4	
150	942.5	24.4		47	14.4	12.4	Turbc at 300' Obsr P.H.

See Legend

No. 39 & 40

Table 13.1 (Continued)

FIELD TEST NO. 41				14 AUGUST 1956			0300 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
160	941.5	24.4		49	15.0	13.0	
385	934.0	26.2		45	15.3	13.3	Gusts
615	926.0	27.0	32	43	15.4	13.4	Ocnl gust
825	919.0	26.7		43	15.1	13.1	Ltng N
985	912.5	26.7		42	14.7	12.7	
1485	897.0	25.5	22	41	13.4	11.3	
2005	879.5	24.9		41	12.9	10.7	3 ltng cells N & NE
2500	863.5	23.6		42	12.4	10.2	
3030	846.5	22.7	22	42	11.7	9.3	
3520	831.5	21.8		46	11.9	9.6	
4025	815.5	20.3		50	11.9	9.6	
4500	801.0	19.1		53	11.8	9.4	
5025	785.5	17.8		55	11.3	8.8	
6060	755.0	15.2	--	67	11.8	9.4	Ocnl draft
7065	**726.5**	**12.3**		**65**	**9.5**	**6.2**	**Bumps**
							Lgt turbc around 2000'
1005	913.0	26.4		40	13.7	11.7	
175	941.0	23.8	32	50	14.8	12.8	Sfc turbc Obsr P.H.

FIELD TEST NO. 42				14 AUGUST 1956			0500 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
180	940.5	22.6		52	14.4	12.4	
410	932.5	23.2	23	49	14.0	12.0	
650	924.5	26.1	22	42	14.2	12.2	
840	918.0	27.0		37	13.1	11.0	
1040	911.0	26.7		39	13.6	11.6	
1540	894.5	25.8	22	39	12.9	10.8	
2025	878.5	24.3		42	12.8	10.6	
2525	862.5	24.0	22	39	11.6	9.2	
3025	846.5	23.4		41	11.8	9.5	
3535	830.5	21.6		43	11.0	8.4	
4045	814.5	20.3		46	10.9	8.2	Lgt turbc
5065	784.0	17.2	32	64	12.7	10.5	
6055	754.5	15.6	--	69	12.3	19.1	Turbc
7610	727.5	12.7		60	9.0	5.4	Turbc
1000	912.5	25.9		42	14.0	12.0	
60	944.5	22.3		46	12.4	10.2	Obsr J.D.

See Legend

No. 41 & 42

Table 13.1 (Continued)

FIELD TEST NO. 43				15 AUGUST 1956			1200 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
50	943.5	31.7	22	33	15.4	13.4	(Temp adjustment too sluggish,
80	942.5	31.7	23	31	15.4	13.3	accuracy ± 0.3 this run only)
190	938.5	31.2	22	33	15.1	13.2	Bumpy
380	932.0	30.4	22	35	15.4	13.4	Drafts ocnl
600	924.5	29.7	22	33	14.0	12.0	Bump
820	917.0	29.0	12	36	14.6	12.6	Draft
1010	910.5	28.4	82	36	14.0	12.0	Smooth over cldy grd
1510	894.0	27.4	32	37	13.3	11.2	Draft
2005	878.0	25.8	22	35	11.8	9.5	Wallowy
2515	861.5	25.0	23	30	9.6	6.4	Gusty
3015	845.5	23.7	22	25	7.3	2.5	Small ocnl gusts
3525	829.5	23.2	13	25	7.1	2.1	
4015	814.0	21.8	--	28	7.4	2.6	
5030	783.5	18.7		41	8.9	5.3	Relatively smooth
6035	754.0	17.2		50	9.9	6.8	
7065	725.0	14.8		50	8.5	4.7	
							Drafts noted at 1500'
990	911.5	29.1	12	35	14.3	12.3	Bouncy
75	942.5	33.6	22	33	17.3	15.2	

FIELD TEST NO. 44				15 AUGUST 1956			1400 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
50	942.5	34.3	22	29	15.6	13.6	(Temp amp closely adjusted,
95	941.0	34.2		29	15.5	13.5	eqp osc ± 0.3°C per 15 sec at this temp)
180	938.0	33.8	24	29	15.1	13.1	(Jitters at high temp.)
380	931.0	32.8	22	29	14.3	12.3	
640	922.0	32.1	13	29	13.9	11.9	
850	915.0	31.6	22	29	13.6	11.5	
1000	910.0	30.6	22	29	12.7	10.5	
1540	892.0	29.3		33	13.6	11.6	
2015	876.0	27.6		33	12.4	10.2	
2515	860.5	26.2	22	36	12.2	9.9	
3025	844.0	24.4	82	36	11.0	8.4	
3515	829.0	22.8	22	39	10.8	8.1	
4055	812.0	21.2		39	9.3	6.8	
5085	781.5	19.1	32	47	10.4	7.5	
6065	752.5	17.0		50	10.0	7.0	
7070	724.0	14.0		63	10.2	7.3	(Jitter ± 0.1°C at this temp)
935	910.5	30.9		29	13.0	10.8	
70	942.0	34.3	33	26	13.8	11.8	Height estimated Obsr P.H.

See Legend

No. 43 & 44

Table 13.1 (Continued)

FIELD TEST NO. 45				15 AUGUST 1956			1700 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
75	938.0	35.3	22	20	16.4	14.4	Fqt bumps Obsr P.H.
190	934.0	34.6	23	20	15.9	13.9	Ocnl drafts
380	927.5	33.9	22	29	15.1	13.1	
620	919.5	33.3	22	29	14.8	12.8	Drafts
835	912.0	32.4	22	29	14.1	12.1	Drafts
1020	906.0	32.0	22	31	14.8	12.8	Wallow
1525	889.0	30.1		31	13.3	11.2	Lgt gusts
2035	872.5	28.7	62	33	13.1	11.0	
2490	857.5	27.1		36	12.6	10.6	
3025	840.5	25.6	22	35	11.7	9.3	
3525	825.0	24.0		38	11.4	8.9	Draft
4025	809.5	22.5		39	10.7	8.0	
5045	779.5	19.7		46	10.5	7.7	
6055	749.5	17.0		52	10.2	7.3	
7065	721.0	14.2		61	10.1	7.1	Brkn clds 2000' above
							Bumpy about 1200
1005	906.5	31.6	33	28	13.3	11.2	Steady run
100	937.0	35.0	63	25	14.4	12.4	Gain 30' on traverse; gusty

FIELD TEST NO. 46				15 AUGUST 1956			1840 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
45	937.5	34.5	22	20	15.7	13.7	Bumpy flight
90	936.0	34.0	22	25	13.6	11.6	
180	933.0	34.0	22	25	13.7	11.6	
400	925.5	33.4	63	25	13.2	11.1	
620	918.0	32.6	22	20	14.3	12.3	
840	910.5	31.6	62	29	13.4	11.3	
1020	904.5	31.2	--	20	13.1	11.0	
1500	888.5	29.8		33	13.9	11.0	
2035	871.0	28.1		36	13.4	10.4	
2515	855.5	26.8		39	13.8	11.7	
3025	839.5	25.0	12	30	13.1	11.0	
3535	823.5	24.4		41	12.6	10.4	
4035	808.0	22.8		41	11.4	8.9	
5065	777.5	20.1		40	10.8	8.1	
6075	749.0	17.0		55	10.9	8.2	(Cld to cld ltng,
7080	719.5	14.4		61	10.2	7.3	strong ltng W & N,
							crew felt static shock
1010	905.0	30.8	32	29	12.8	10.6	on final approach)
60	937.0	32.8	23	25	12.8	10.6	Sprinkling Obsr J.D.

See Legend

No. 45 & 46

Table 13.1 (Continued)

FIELD TEST NO. 47				20 AUGUST 1956			1000 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
50	953.5	15.5		55	9.9	6.8	
80	952.5	15.5	23	54	9.7	6.6	
180	949.0	15.2		55	9.7	6.6	Bumps
400	941.0	14.7		55	9.4	6.1	
640	933.0	13.8		60	9.7	6.5	Bumps
870	925.0	13.3		63	9.8	6.7	
1010	920.5	12.7		65	9.7	6.5	
1520	903.0	11.6		58	8.1	3.9	
2025	886.5	10.5		62	8.1	3.9	
2535	869.5	9.1		66	7.8	3.4	
3025	854.0	8.4		76	8.5	4.7	
3525	841.5	7.0		80	8.2	4.1	
4025	822.5	5.9		70	6.7	1.2	
5055	791.5	3.6	82	71	5.7	-0.8	Lwt sctd cld at 4500
6055	762.0	1.7		71	5.0	-2.4	
7080	732.5	0.2		90	5.7	-0.9	
							Lgt turbc at 2400
1000	921.0	12.8	32	64	9.7	6.5	Turbc
40	953.5	16.5	32	52	10.0	7.0	Obsr J.D.

FIELD TEST NO 48S				20 AUGUST 1956			1200 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
50		18.0	32	49	10.3	7.4	
85	951.5	17.4	22	46	9.2	5.7	
175	948.5	17.5		49	9.8	6.8	
385	941.5	16.9	22	49	9.6	6.3	
625	933.0	16.2		51	9.5	6.3	
835	926.0	15.5		51	9.2	5.8	
1015	920.0	15.0		53	9.2	5.8	Turbc
1525	902.5	13.6		62	9.8	6.7	Hvy turbc
2520	870.0	10.8		66	8.7	5.0	
3020	854.0	9.3		77	9.2	5.8	
3610	838.5	8.0		80	8.8	5.1	
4030	822.0	6.5		83	8.3	4.0	
5040	791.5	4.3	32	88	7.5	2.8	Cloud layer
6040	762.0	2.2		90	6.6	1.0	4600-5400'
7075	732.5	-0.2	--	95	6.3	-0.5	
995	920.5	15.1	36	56	9.7	6.8	Turbc
65	952.5	18.6	22	49	10.6	7.9	Obsr J.D.

See Legend

No. 47 & 48S

Table 13.1 (Continued)

FIELD TEST NO. 48R				21 AUGUST 1956			0900 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
75	944.5	16.2		74	13.9	11.9	(T eq response rate checked) Bouncy - sudden drafts
185	940.5	15.8		72	13.2	11.0	
405	933.0	15.2		75	13.2	11.1	Bouncy
645	925.0	14.5		79	13.3	11.2	Continual turbc
830	918.5	13.8	22	81	13.1	11.0	
1015	912.5	13.4		82	12.9	10.7	Less turbc
1595	895.5	13.3	28	80	12.4	10.2	Inversion osc ± 0.6°C in half mile
2040	878.5	14.2		65	10.8	8.1	Smooth ocnl bump
2520	863.0	13.0		69	10.5	7.7	
3050	846.0	11.7		65	9.2	5.8	Smooth
3540	**830.5**	**11.3**		**60**	**8.4**	**4.1**	**(Vsby exceptional. Haze)**
4050	**815.0**	**10.8**		47	6.7	1.0	(Dark to S)
5050	784.5	11.7		39	5.4	-1.5	(White streak E horizon)
6060	755.0	10.9		36	5.1	-2.2	
7095	725.5	9.1		40	4.6	-3.4	
995	913.0	14.2	34	81	13.3	11.2	Bumps at 1500', temp drops
95	944.0	17.4	32	66	13.3	11.2	Gusts Obsr P.H.

FIELD TEST NO. 49				21 AUGUST 1956			1100 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
75	943.0	20.5	23	49	11.9	9.5	(T eq response ± 9.1°C/10 sec) Side gust felt
165	940.0	19.9	22	50	11.7	9.3	
375	933.0	19.6		50	11.5	9.0	Up & downs
615	924.5	18.5		52	11.3	8.8	
835	917.0	18.1		55	11.7	9.2	Bumpy
995	912.0	17.5		58	11.8	9.4	Drafts
1505	895.0	16.3	22	64	12.1	9.8	Sharp gusts, wallowy
2000	878.5	15.6	22	64	11.6	9.1	
2510	862.0	14.5		62	10.4	7.6	
3040	845.0	14.2	32	70	11.3	9.0	Lgt drafts felt to 3500'
3520	830.0	14.0		60	9.8	6.7	
4030	814.0	13.0		62	9.5	6.3	RH dip around 3800'
5030	784.0	11.7		33	4.5	-3.5	RH drop about 4800'
6060	754.0	11.1		35	4.7	-3.2	
7075	725.0	9.0		35	4.1	-4.8	
995	912.0	18.4	34	60	12.8	10.7	Neg 1/2 G at about 1800' Rough
85	943.0	21.9		49	12.8	10.6	Obsr P.H.

See Legend

No. 48R & 49

Table 13.1 (Continued)

FIELD TEST NO. 60				21 AUGUST 1956			1400 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
110	939.0	26.3	23	43	14.7	12.7	
185	936.5	25.6	23	43	14.1	12.1	
390	929.5	25.2	23	43	13.8	11.8	
650	921.5	24.3	23	45	13.8	11.7	
850	914.0	23.7	22	45	13.3	11.2	
1020	908.0	22.9	22	46	13.0	10.8	
1530	891.0	21.3		52	12.6	10.4	
2045	873.5	19.8	22	54	12.8	10.6	
2535	858.5	18.6		52	11.4	9.9	
3055	842.0	17.8	82	36	7.4	2.6	Sharp temp drop
3555	826.0	16.8	32	36	6.9	1.7	
4045	811.0	15.4		38	6.7	1.4	
6055	780.5	12.7		38	5.6	-1.0	
6085	750.5	10.8	62	35	4.6	-3.4	
7040	723.5	10.1		20	3.6	-8.3	
							at 3400 turbc
1010	908.5	23.7		45	13.4	11.2	
100	939.5	27.8	23	36	13.3	11.2	Obsr J.K.

FIELD TEST NO. 51				21 AUGUST 1956			1530 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
		30.5					
75	936.0	27.4		39	14.1	12.1	Yawing in cross wind
175	935.5	27.4	22	39	14.2	12.1	Drafts, Pireps
365	929.0	26.8	22	40	14.0	12.0	Hard to hold El at 600
615	920.5	26.4	23	42	14.4	12.5	Wallows, bumps, drafts
805	914.0	25.7	62	41	13.6	11.5	Drafts
1015	907.0	25.0	--	42	13.3	11.2	
1525	890.0	23.5	22	43	12.5	10.2	
1990	875.0	21.6		45	11.7	9.4	
2520	858.0	20.4	22	46	11.2	8.6	Hard to hold wings level
3015	842.0	18.8		47	10.2	7.3	
3500	827.0	17.0		50	9.9	6.8	Bumpy
4015	811.0	15.4		68	12.0	6.8	Rocky like boat
5030	780.5	12.9		71	10.8	8.1	
6035	751.0	9.9		80	10.0	7.0	Rocky
6975	724.5	8.0	22	50	5.5	-1.3	R H Response marked
6500	737.8	8.4		82	9.3	5.9	In clear (base at 6800')
							In cloud tmp drops 2°C
1015	907.0	25.3		30	12.6	10.4	
85	939.5	28.6		37	14.4	12.4	Obsr P.H.

See Legend

No. 50 & 51

Table 13.1 (Continued)

FIELD TEST NO. 52				24 AUGUST 1956			1115 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
50	950.5	22.9	23	38	10.5	7.7	
115	948.0	22.3	23	38	10.3	7.4	
175	946.0	22.0	22	38	10.1	7.1	
385	938.5	21.4	22	39	10.0	6.9	
630	930.0	20.8	22	39	9.6	6.4	Bumpy
825	923.5	19.8		44	9.6	6.3	
1015	917.0	19.3		42	9.5	6.2	
1515	900.5	17.8	82	47	9.6	6.4	Drafts
2010	884.0	16.6		45	8.5	4.6	Drafts
2535	867.0	15.2		47	8.2	4.0	
3030	851.0	13.6		50	7.9	4.5	
3535	835.0	13.2	23	47	7.1	2.1	Undulations on traverse
4030	819.5	12.8	33	50	7.4	2.7	Smooth R H change 4500'
5060	788.5	12.5		70	10.3	7.4	Shallow Ac to S at
6060	759.0	10.3		75	9.6	6.4	Top haze layer
7085	730.0	8.5		60	6.8	1.4	Cold noted on descent. Bumpy around 4000'
1005	917.5	19.5	32	42	9.6	7.4	Pireps updraft, also recorded
60	950.0	23.1	23	35	10.1	7.1	Obsr P.H.

FIELD TEST NO. 53				24 AUGUST 1956			2000 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
				37	8.7	5.0	
165	942.5	22.7	--	39	10.7	8.0	One bump
395	934.5	22.5		39	10.6	7.8	Very smooth
635	926.0	21.6	--	39	10.1	7.2	
835	919.5	21.1		41	11.3	7.4	
1015	913.5	20.7		41	10.1	7.1	Smooth
1520	896.5	20.1		38	8.9	5.4	
2020	880.0	18.6		39	8.4	4.4	
2520	863.5	17.1		41	8.1	4.0	Minor bump
3030	847.5	16.0		43	7.8	3.4	
3530	831.5	15.0	32	47	8.0	3.8	Tiny bump
4035	816.0	15.2	22	48	8.3	4.3	
5045	785.5	13.9		50	8.0	3.8	
6065	755.5	12.3		43	6.2	0.2	
7070	727.0	10.1		48	5.9	-0.4	Above haze
995	914.0	20.8		39	9.6	6.4	
185	941.5	21.4		42	10.7	8.0	Obsr P.H.

See Legend

No. 52 & 53

Table 13.1 (Continued)

FIELD TEST NO. 54				24 AUGUST 1956			2200 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
6	948.5	18.1		53	11.2	8.6	Take off
160	943	19.9		47	11.2	8.6	Slight turbc
370	930	20.2		46	11.3	8.8	
610	928	21.0		41	10.5	7.7	
820	920.5	20.4		42	10.2	7.4	Smooth
990	915	20.5		42	10.4	7.5	Bump
1505	897.5	19.6		40	9.5	6.2	
2195	875.0	1[illegible].8		43	9.6	6.4	
2495	865.5	18.0		45	9.5	6.2	
3000	840.0	17.4		45	9.1	5.6	
3495	833.5	17.0		46	9.1	5.6	
4005	817.5	16.3		45	8.4	4.4	
5005	787.5	14.4		47	8.0	3.7	
6030	757	12.6	--	36	5.7	-1.6	
7050	728	10.3		64	8.2	4.1	
970	916	20.2		42	10.1	7.1	(Pireps higher engine output rqrd all traverses)
160	943	19.5		47	10.9	8.2	
6	948.5	19.1	--	50	10.8	8.2	Landing Obsr P.H.

FIELD TEST NO. 55				25 AUGUST 1956			0100 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
6		16.4		67	12.7	10.6	Take off
155	942.5	17.1		58	11.8	9.4	
405	934.0	17.4	32	54	11.2	8.6	
615	927.0	18.7		50	11.2	8.6	
845	919.0	19.6		46	10.8	8.2	Pireps turbc noted below
1015	913.5	19.6		46	10.6	7.8	
1525	896.0	20.0		43	10.1	7.2	
2000	880.5	19.8		45	10.4	7.6	
2490	864.5	19.1		48	10.8	8.1	
3020	847.5	19.2		49	11.2	8.6	
3515	832	18.1		49	10.2	7.2	
4025	816.5	17.1		52	10.2	7.6	Steady going
5020	786	15.0		52	9.2	5.7	
6040	758.5	13.2		48	7.4	2.6	
7035	728	11.2		41	5.5	-1.2	
985	914.5	19.3		45	10.2	7.2	
195	941	16.4		62	12.0	9.7	
6	948	16.5		60	11.6	9.1	Landing Obsr J.K.

See Legend

No. 54 & 55

Table 13.1 (Continued)

FIELD TEST NO. 56				25 AUGUST 1956			0300 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
6	948	16.4		70	13.2	11.2	Take off
155	942.5	16.0		68	12.8	10.6	Lgt turbc
385	934.5	17.2		63	12.8	10.6	Lgt turbc
625	926.5	17.9		57	12.0	9.7	
855	918.5	19.3		49	11.1	8.5	
1015	913.5	19.6		47	10.9	8.2	Possible Neg G
1515	896.5	20.3	32	46	11.0	8.4	
2020	880.0	19.9		46	11.3	8.8	
2510	864.0	19.6		49	11.2	8.6	
3020	847.5	19.7		48	11.0	8.4	Possible Neg G
3510	832.5	18.9		49	10.8	8.1	
4030	816	18.4	32	48	10.3	7.4	
5040	785.5	16.3		46	8.7	4.9	Some lgt turbc
6040	756.5	13.2		53	18.8	4.4	Draft
7055	727.5	10.?		65	8.5	4.6	Down Draft. Undulations Ac E15000MSL
985	914.5	19.7	62	43	10.5	7.7	
165	942.5	16.2		68	12.8	10.6	Rough now
6	948.0	16.5		63	12.6	10.4	Landing Obsr P.H.

FIELD TEST NO. 57				25 AUGUST 1956			1730 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
50	938.5	33.7		25	13.4	11.3	
95	936.5	33.7		25	13.4	11.4	Turbc
195	933.5	33.1	22	29	14.0	12.6	
395	926.5	32.7	82	29	14.4	12.4	
615	919.0	32.1	22	29	13.9	11.0	
845	911.0	31.1		29	13.2	11.1	Turbc
1035	905.5	30.5	22	29	12.6	10.4	
1545	888.0	22.8		30	8.4	4.5	
2035	872.0	27.6	22	34	9.2	5.8	
2535	856.0	25.7		34	10.8	0.4	
3030	841.0	23.9		36	10.7	8.0	
3550	824.0	22.2		39	10.5	7.7	
4040	809.0	21.4		38	9.7	6.5	
5070	778.0	18.2		41	8.7	5.0	
6070	749.0	16.2		40	7.3	2.5	
7075	720.5	13.4		31	4.8	-3.0	
1015	905.5	30.4		29	12.7	10.4	
60	938.0	33.4		29	14.9	12.9	Obsr J.D.

See Legend

No. 56 & 57

Table 13.1 (Continued)

FIELD TEST NO. 58				25 AUGUST 1956			1930 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks Temp eq damping checked OK
190	932.0	31.1		31	14.0	12.0	Smooth
410	924.0	32.2	--	26	12.4	10.1	Anvil cld West
660	916.0	32.1	62	26	12.4	10.1	Floccus overhead
870	909.0	31.2	22	26	11.7	9.3	
1080	902.5	30.5	62	29	12.6	10.4	
1560	886.0	29.2		29	11.8	9.4	Bluish haze noted
2055	870.0	27.6	22	29	10.8	8.0	
2545	854.5	26.2		29	10.0	7.0	
3070	837.5	24.9	--	33	10.3	7.4	Ocnl very lgt updraft
3565	822.0	22.7		35	9.6	6.4	
4075	806.5	21.2	22	35	8.9	5.1	Clear overhead
5080	776.5	18.4	22	35	7.4	2.6	
6075	747.5	16.3	--	25	4.7	-3.2	
7100	718.6	13.3		29	4.4	-3.9	
							Floccus overhead
1010	904.5	30.3	62	28	12.1	9.8	Ocnl bump
215	931.0	30.1	13	30	13.8	10.6	Obsr P.H.

FIELD TEST NO. 59				25 AUGUST 1956			2230 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
		23.8		44	13.0	10.8	
190	935.0	28.0		35	13.4	11.2	
400	928.0	29.8		31	13.0	10.8	
630	920.0	31.2		26	11.7	9.2	
850	912.5	30.8		26	11.5	9.0	
1050	906.0	30.9		26	11.5	9.1	
1530	890.0	29.7	--	26	10.8	8.1	
2030	873.5	28.5	--	26	10.1	7.1	
2525	857.5	26.8	--	29	10.3	7.4	
3035	841.5	25.4		28	9.2	5.7	
3525	826.0	23.9		30	9.0	5.5	
4025	811.0	22.3	22	30	8.2	4.1	
5035	780.5	19.1	22	36	8.0	3.8	
6075	750.0	15.0		40	7.2	2.2	
7060	722.0	13.1	--	46	7.0	1.9	
							T lag test 63% in few sec
1020	907.0	30.5		26	11.4	8.8	
170	936.0	27.8		35	13.2	11.1	Obsr J.D.

See Legend

No. 58 & 59

Table 15.1 (Continued)

FIELD TEST NO. 60				27 AUGUST 1956			0030 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
6	938.0	24.2		40	12.1	9.8	Take off
185	932.0	26.8		34	12.0	9.7	Turbc below 600 ft
385	925.0	28.1	23	31	11.8	9.4	
625	917.0	28.8		28	11.1	8.5	
825	910.0	29.0		29	11.6	9.2	
1015	903.5	28.3		29	11.2	8.6	
1515	887.0	29.0		26	10.3	7.4	
2005	871.0	27.9		29	10.9	8.3	
2490	855.5	26.6		28	9.8	6.7	
3025	838.5	25.3		28	9.1	5.6	
3510	823.5	23.8		30	9.0	5.4	
4030	807.5	22.2	--	33	8.8	5.2	
5020	777.5	19.1		33	7.2	2.4	
6030	748.5	16.1		36	6.8	1.2	
7095	718.5	13.1		42	6.5	0.8	
1025	903.5	29.9		25	10.4	7.5	
105	931.5	26.6	--	34	11.8	9.5	
6	938.0	25.7		36	11.9	9.5	Landing Obsr J.D.

FIELD TEST NO. 61				27 AUGUST 1956			1100 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
6	934.0	32.5	23	39	19.1	16.8	Take off
90	931.0	28.7	23	33	13.2	11.0	Bouncy
190	927.5	28.6	23	33	13.0	10.0	
380	921.0	28.0	22	33	12.6	10.4	Lift
645	912.0	27.3	23	33	12.1	9.8	Bouncy
845	905.5	26.5		32	11.2	8.7	G felt in drafts
1015	900.0	26.2	22	34	11.8	9.4	Drafts
1525	883.0	24.9	24	35	11.0	9.4	
2030	866.5	24.9	62	32	10.2	7.3	Small bumps
2525	850.5	24.4	64	32	10.0	7.0	
3040	834.0	22.5	--	32	8.8	5.1	
3540	819.0	21.0		35	8.7	4.9	Bumps with drafts
4040	803.5	20.3	22	32	7.8	3.4	
5045	773.5	17.4		38	7.0	3.1	Wallowy
6050	744.5	14.7	22	47	7.9	3.6	
7065	710.0	11.8	--	50	7.0	1.9	Not smooth
995	900.5	26.4	33	34	11.8	9.4	Bouncy & drafts
90	931.0	29.6	14	31	12.8	10.7	
6	934.0	30.2		32	13.6	11.6	Landing Obsr P.H.

See Legend

No. 60 & 61

Table 13.1 (Continued)

FIELD TEST NO. 62				27 AUGUST 1956			1400 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
6	934.0	28.9		43	17.0	15.0	Take off
90	931.0	28.3		30	15.2	13.2	Turbc
180	928.0	28.3	22	36	14.0	12.0	
380	921.5	27.8		36	13.6	11.6	
620	913.0	27.8		35	13.2	11.1	
810	907.0	28.0		31	11.8	9.4	
1010	900.0	27.7		31	11.6	9.1	
1505	883.5	26.4	32	32	11.0	8.4	
2015	867.0	25.5		30	9.9	6.8	
2505	851.5	24.3	22	30	9.2	5.8	
3015	835.5	22.6	62	32	8.9	5.2	Bumps
3515	820.0	20.9		36	9.0	5.4	
4025	804.0	19.4	22	39	8.8	5.1	Bumps
6035	774.0	16.6		43	8.1	4.0	
6045	744.5	13.6		49	7.7	3.2	
7050	716.5	12.6		51	7.4	2.8	
990	901.0	28.2	--	30	11.4	9.0	
80	931.5	31.6	62	26	12.0	9.6	
6	934.0	31.4		32	14.6	12.7	Landing — Obsr J.D.

FIELD TEST NO. 63				27 AUGUST 1956			2000 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
6	931.0	28.3		31	11.9	9.6	Take off
195	925.0	31.4	--	33	15.2	13.2	Smooth
385	918.5	31.2		33	15.1	13.2	Smooth
630	910.0	30.6		31	13.8	11.7	
835	903.0	30.0		33	14.2	12.2	
1015	807.0	29.7	--	33	13.8	11.8	
1525	880.5	28.2	--	33	12.8	10.6	Smooth
2020	864.5	26.8		36	12.6	10.4	
2520	845.5	25.4		36	11.6	9.2	
3950	831.5	23.7		36	10.6	7.8	Slight lift
3540	816.5	22.5		35	9.6	6.4	Smooth
4055	801.0	21.6		30	8.2	4.0	
5050	771.0	18.5		33	6.9	1.6	
6070	741.5	16.0		32	5.9	-0.4	Smooth
7075	713.5	13.1	--	33	5.0	-2.4	
1005	897.5	29.1	32	33	13.4	11.4	
180	925.5	31.2		33	15.0	13.0	
6	931.0	28.7		38	15.0	13.0	Landing Obsr P.H.

See Legend

No. 62 & 63

Table 13.1 (Continued)

FIELD TEST NO. 64				27 AUGUST 1956			2200 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
6	931.0	20.5		69	16.6	14.6	Take off
205	924.0	30.0		33	14.0	12.0	
435	916.0	30.4	22	33	14.4	12.4	Very steady going
670	908.5	30.0	22	31	13.2	11.2	
890	901.0	30.6	22	29	12.4	10.1	
1065	895.0	29.7		29	12.1	9.8	
1560	879.0	28.8		29	11.6	9.1	
2080	862.0	27.5		29	10.7	8.0	
2575	846.0	26.1	22	30	10.2	7.3	
3070	830.5	24.8		32	10.0	7.0	
3565	815.5	23.0		32	9.2	5.8	
4070	800.0	21.8		28	7.4	2.7	
5090	769.5	18.7		33	7.2	2.0	
6080	741.0	15.6		33	5.9	-0.5	
7105	712.5	12.6		40	5.8	-0.6	
1045	896.0	28.9		31	12.5	10.3	
195	924.5	27.7	24	42	15.6	13.6	
6	931.0	25.9		43	14.4	12.4	Landing Obsr J.K.

FIELD TEST NO. 65				29 AUGUST 1956			1900 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
6	932.0	24.5		33	10.3	7.4	Take off
190	925.5	26.4	22	30	10.2	7.4	Smooth ocnl bump
386	919.0	26.3		28	9.6	6.4	
645	910.0	25.8		28	9.3	6.0	Sunset 19:12 by tables
875	902.5	25.2		30	9.7	6.5	
1045	897.0	24.7		32	10.0	7.0	
1530	881.0	22.6		32	9.0	5.4	
2020	865.0	21.7		36	9.3	6.0	
2510	849.0	20.0		39	9.0	5.6	
3040	832.5	18.6	22	43	9.2	5.8	
3540	817.0	17.5	--	46	9.2	5.8	
4050	801.5	15.8		49	8.7	5.0	Slight draft
5050	771.5	13.3		50	7.6	3.0	Occasional light turbc
6080	741.5	11.8		43	6.0	-0.2	
7105	713.0	9.4		36	4.3	-4.2	
1005	898.0	24.9		32	10.2	7.4	
195	925.5	25.7	33	32	10.6	7.8	Slt turbc
6	932.0	24.7		33	10.4	7.4	Landing Obsr P.H.

See Legend

No. 64 & 65

Table 13.1 (Continued)

FIELD TEST NO. 66				30 AUGUST 1956			2133 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
6	932.0	20.7	82	46	11.2	8.8	Take off delay - flat tire
100	925.5	23.6		36	10.5	7.6	
400	918.5	25.8	65	32	10.5	7.8	Gust or bump
640	910.5	25.7		30	10.0	7.0	Draft or bump
885	902.0	25.2	--	32	10.4	7.5	
1060	896.5	24.4	82	33	10.0	7.0	
1560	880.0	23.1	13	30	8.6	4.8	
2025	863.0	22.8	13	25	7.0	1.8	
2555	848.0	22.1	12	25	6.8	1.2	Smooth
3085	831.0	20.0	22	25	6.1	0.0	
3580	816.0	19.4	32	31	6.9	1.8	
4090	800.0	18.0	32	32	6.8	1.5	
5080	770.5	15.2	22	36	6.3	0.2	
6095	741.5	12.6	32	39	5.7	-0.8	Slt turbc
7120	712.5	9.9		40	4.9	-2.8	Slt turbc
[illegible]	897.5	24.5		32	10.0	7.0	
205	925.0	22.3		41	11.1	8.5	Slight turbc
6	932.0			38	10.2	7.2	Landing Obsr P.H.

FIELD TEST NO. 67				30 AUGUST 1956			0020 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
6	932.0	19.7	--	48	10.5	8.2	Take off
220	924.5	21.7		41	10.7	8.0	Bumpy below 300 ft
430	917.5	24.6	25	36	11.0	8.4	Slight turbc
670	909.5	24.6	82	35	10.9	8.2	
880	902.5	23.7	62	37	10.2	7.2	Smooth
1080	896.0	23.2	82	36	10.4	7.4	
1570	879.5	21.6		46	12.0	9.6	
2075	863.5	21.0		42	10.5	7.8	
2545	848.5	20.5		33	7.9	3.5	
3065	832.0	20.0	22	29	6.8	1.4	
2565	816.5	19.6	32	25	5.7	-1.0	Ltng SW
4085	800.5	18.4	32	28	5.1	-0.2	Pireps slt turbc
5085	771.0	15.2		35	6.2	0.0	Slt turbc
6090	741.5	12.6		36	5.4	-1.6	
7116	713.5	9.7		40	4.8	-2.8	Turbc wallowy
1040	897.0	23.2		41	11.7	9.3	
225	921.5	22.1	62	36	10.4	7.5	Rough at 200' Bumps
6	932.0	22.1		37	9.9	6.8	Landing Obsr P.H.

See Legend

No. 66 & 67

Table 18.1 (Continued)

FIELD TEST NO. 68				30 AUGUST 1956			0230 CST
Z_p (ft)	P (mb)	T (°C)	#	RH (%)	e (mb)	T_d (°C)	Remarks
6	951.0	21.6	22	43	11.2	8.6	Take off Obsr P.H.
200	924.5	22.8	04	39	10.8	8.1	Bump not turbc
420	917.0	23.4	14	36	10.3	7.4	
675	908.0	23.8	24	35	10.5	7.6	Turbc
880	902.0	23.6	12	32	9.3	6.0	
1050	896.0	23.2		32	9.1	5.6	Turbc draft
1540	879.5	22.2	22	32	8.7	5.0	
2040	863.5	22.2	12	28	7.7	3.2	Lgt bump
2525	848.0	22.6	32	25	6.9	1.6	
3045	831.5	21.4	62	25	6.4	0.7	Wallowy
3565	815.5	20.2	--	25	5.9	-0.4	
4055	800.5	18.0	12	26	6.3	0.4	Pireps rocky
5065	770.5	16.0	22	28	5.2	-2.0	Down draft at 4500
6075	741.0	13.2		33	5.0	-2.3	
7100	712.5	10.1		36	4.5	-3.8	Turbc
							Gusts in descent
1010	897.0	25.0	23	27	8.8	5.0	Bouncy
200	924.0	25.6	82	38	11.0	8.4	Down draft at 250'
6	931.0	24.1		35	10.6	7.8	Mild wind shift encountered. In about 2 miles 2 cycles + 1°C temp change at 725', updraft with ΔT 2.1 C in about 1/2 mile

See Legend

No. 68

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